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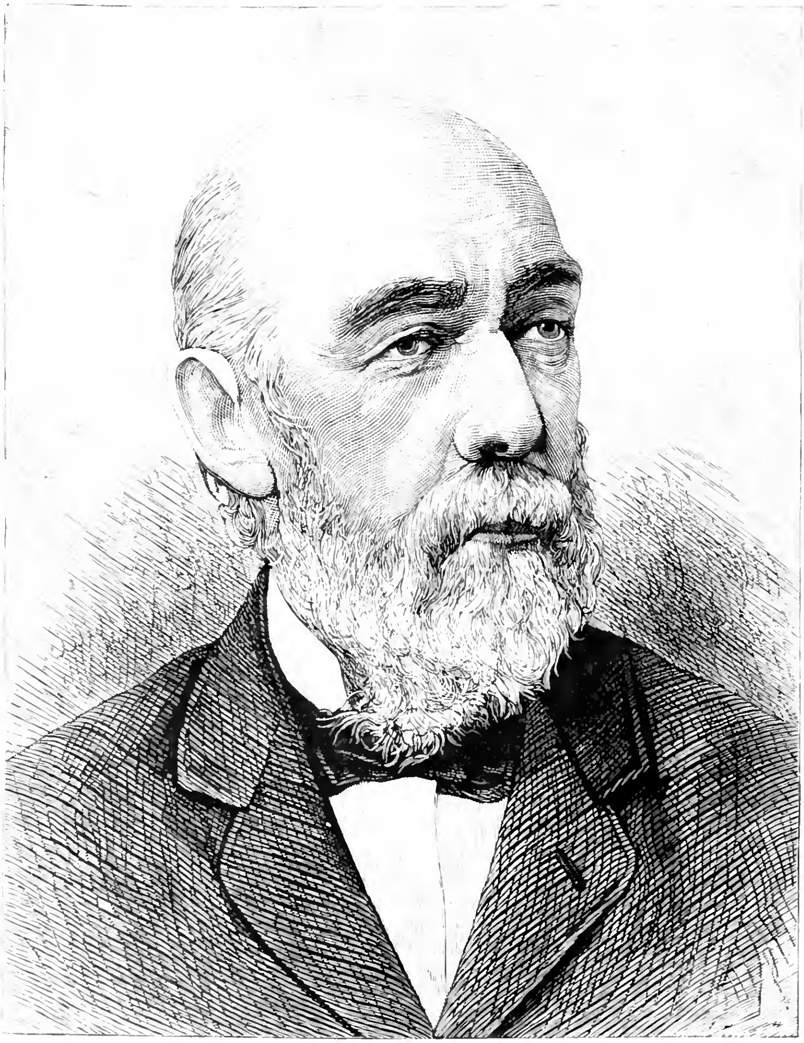

JAMES FERGUSSON.

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# THE NATURAL *VERSUS* THE SUPERNATURAL.

By JOHN BURROUGHS.

OUR theological professors make a mistake when they think they have weakened or parried the objections of science to their doctrines by pointing to the fact that science is constantly revising or reversing its own conclusions; that what was deemed good science at one time is found to be false science at another. "This modern infallibility which men call science" is a phrase used by Rev. Dr. Jenkins in criticising in the "Evangelist" my paper on "Science and Theology" in the December number of this magazine.

"We who are yet upon the safe side of the ministerial dead-line," he says, "can remember when it was scientific to assert the diverse origin of the race 'from four or six pairs' of progenitors; and we have come to the day in which science will not leave us as much as Adam and Eve for a beginning. We have learned the igneous origin of granite, just in time to be commanded to unlearn it, and substitute an aqueous origin." And the conclusion, therefore, is that science is discredited, and that he who builds upon it plants his house upon the sands. But science makes no claim to infallibility; it leaves that claim to be made by theology. "This shifting of positions and this changing of results" but marks its growth, its development; and it is precisely this active and inquiring spirit, this readiness to correct its errors, and this eagerness to reach a larger generalization, that makes it the enemy of the traditional theology. It abandoned the Ptolemaic system of astronomy for the Copernican, because the latter was found to be the most complete generalization; but theology still adheres to its Ptolemaic system of things. To seek to discredit science because it has made mistakes, and has had to unlearn many things, is to deny the very principle of progress; it is to reflect upon the child because he grows into a man. The main outlines of the physical universe science has undoubtedly finally settled; the great facts of astronomy and geology are not to be reversed or set aside. It is only in the details, the filling in of the picture, that errors are still likely to occur. No, what theology has to fear, and what is working such mischief with it, is not the "infallibility" of science, but it is the scientific spirit, the spirit that demands complete verification, that applies past experience to new problems, that sees that immutable laws lie at the bottom of all phenomena, and that is skeptical of all exceptions to the logical course of events until they are irrefragably proved.

Science is ignorant enough, without doubt, about many things. After it has done its best, the mystery of creation is as deep as before. But what it has taught the race, and what the race can never unlearn, is, that the sequence of cause and effect is inviolable, that the order of the physical universe is rational, that creation is not an historical event but a perpetual process, that there is no failure and no disorder in Nature, and that to approximate to anything like a right understanding of things the personal, or, if I may coin the word, the *anthrocentric*, point of view must be abandoned.

Dr. Jenkins is unfortunate in confronting the kind of "exceptions" which I aver science can not recognize with the fact that water, in opposition to all other material substances, *expands* under a certain degree of cold. But is there any known exception to this law of water? Has water ever been known to reverse this process in freezing? If so, the exception would indeed stagger science; it would be a miracle. A child born of a woman, but without an earthly father, and of a superhuman species, is the kind of exception which I averred science can not recognize; but does this bear any analogy to the exceptional behavior of water while freezing, when compared with other substances? It used to be believed that in every animal that possessed a circulation the blood always took one definite and invariable direction, but, in 1824, Huxley says, it was discovered that a class of animals called *Ascidians* furnished an exception; the heart of these animals, after beating a certain number of times, stops, and then begins to beat in the opposite way, so as to reverse the course of the blood, which returns by-and-by to its original direction. Such an exception does not disturb the man of science; it only teaches him greater caution in making his deductions. But if one Ascidian, and but *one*, could be found whose heart beat like that of other animals, that would be a puzzle to him. Or if one comet, and only one, should appear carrying its tail toward the sun instead of from it, cometary astronomy would be reduced to chaos. A floating feather is no exception to the law of gravitation, but a floating stone and a falling feather would be an exception. Science as well as experience finds exceptions to general rules everywhere, but these exceptions are constant and as strictly the result of natural law as anything else. Faith in the continuity of Nature, upon which the scientist builds, no less than every man in the conduct of his life, does not mean sameness or identity of all physical processes, but it means identity of these processes under like conditions. Given the same conditions, and the same results *always* follow. Water obeys its laws under low temperature, and iron its. It is not long since that the Bishop of Carlisle urged as an argument against the uniformity of Nature the fact that the weather is changeable! If his lordship could have shown that the laws which govern the formation of clouds, and the precipitation of rain and snow are changeable, or ever work inversely, he would have made out his case. The fathers of the Church believed that the flesh of the peacock never decayed. St. Augustine said he had ascertained by experiment that this is a fact. If this were so, it would indeed be a remarkable exception; but the man of science would at once set about ascertaining its natural cause, without for one moment attributing it to a supernatural one. But without trying the experiment ourselves, does any sane man to-day doubt that either the saint deceived himself, or else that he was not honest? His statement is incredible, because it contradicts all the rest of our knowledge relating to the decomposition of animal tissue.

I suppose the last thing our fathers would have thought of doing, would have been to try to reconcile their conception of Christianity with their stores of natural knowledge. They did not feel the need, which we to-day feel so keenly, of any such reconciliation. They cherished their faith as something apart, something not founded in the order of this world, something to which science and all that pertains to the "natural man" are necessarily strangers. The order of this world is carnal; it is full of evil, and is separated by an impassable gulf from the sacred and the divine. A vast number of most excellent and pious people still feel in this way about their religious belief; it is all the more sacred and precious to them because it has no relation to the natural course of mundane things. It forms for them an escape from the humdrum, from the failures, and from the materialism of life. Who can recall without deepest sympathy and love the religious beliefs and observances of the many simple and credulous people he has known in his youth, perhaps of his own parents or grandparents, with their fervid piety but merciless creeds, their faith in their church and in the saving power of its sacraments, their unquestioning belief in the literal truth of the Bible, every word of it—the Fall, the Flood, the miracles, and all? What a refuge their faith was to them in times of trouble; what an avenue of escape into spiritual and ideal regions! It saved them; why can it not save us? For the simple reason that it is no longer credible to us: we are born into another world; we can not believe the old creed, try we never so hard. It was adequate to their knowledge, to their development, but it is not adequate to ours. The old terms and symbols satisfied them, but they are fast becoming obsolete to us. The whole aspect of the universe has changed. But our salvation is to be had upon essentially the same terms as our fathers'—namely, by fidelity to what we see and feel to be true.

"Few minds in earnest," says Cardinal Newman, "can remain at ease without some sort of rational grounds for their religious belief." But it is equally true that half-formed, half-developed minds, which means the great mass of the people of any age, rather draw back from exposing their faith to a light so common, so secular as that of reason. Plutarch quotes Sophocles as saying that the Deity is

"Easy to wise men, who can truth discern,"

but adds that the vulgar look with high veneration upon whatever is extravagant and extraordinary, and conceive a more than common sanctity to lie concealed under the veil of obscurity. The average mind clings to the mysterious, the supernatural. Goethe, as lately quoted by Matthew Arnold, said those who have science and art have religion; and added, let those who have not science and art have religion, that is, let them have the popular faith; let them have this escape, because the others are closed to them. Without any hold upon the ideal, or any insight into the beauty and fitness of things, the people turn from the tedium and the grossness and prosiness of daily life, to look for the divine, the sacred, the saving, in the wonderful, the miraculous, and in that which baffles reason. The disciples of Jesus thought of the kingdom of heaven as some external condition of splendor, and pomp, and power which was to be ushered in by-and-by by hosts of trumpeting angels, and the Son of man in great glory, riding upon the clouds, and not for one moment as the still small voice within them. To find the divine and the helpful in the mean and familiar, to find religion without the aid of any supernatural machinery, to see the spiritual, the eternal life in and through the life that now is—in short, to see the rude, prosy earth as a star in the heavens, like the rest, is indeed the lesson of all others the hardest to learn.

But we must learn it sooner or later. There surely comes a time when the mind perceives that this world is the work of God also and not of devils, and that in the order of Nature we may behold the ways of the Eternal; in fact, that God is here and now in the humblest and most familiar fact, as sleepless and active as ever he was in old Judea. This perception has come and is coming to more minds to-day than ever before—this perception of the modernness of God, of the modernness of inspiration, of the modernness of religion; that there was never any more revelation than there is now, never any more miracles or signs and wonders, never any more conversing of God with man, never any more Garden of Eden, or fall of Adam, or thunder of Sinai, or ministering angels, etc.; in fact, that these things are not historical events, but inward experiences and perceptions perpetually renewed or typified in the growth of the race. This is the modern gospel; this is the one vital and formative religious thought of modern times.

The mind that has fully opened to this perception no longer divorces its faith from its reason, no longer rests in the idea of a dualism in creation or opposition between God and the world, and can not feel at ease until its religious belief is in harmony with its natural knowledge. The two must not be at war. What we hope for, what we aspire to, must be consistent with what we know. Faith and science must, indeed, go hand in hand. The conception of religion as a miraculous scheme for man's redemption interpolated into history, God's original design with reference to man having miscarried, is entirely undermined and overthrown by the perception of the unity and consistency of creation as revealed by science.

Who does not see that it adds vastly to the credibility of a doctrine or theory to find that it fits in with other things, that it is not an exception or an isolated circumstance, but is in a line with facts and principles of the truth of which we are already assured? Suppose the theory of Christianity, as popularly held, had something like the breadth of application, or the same warrant and basis in the constitution of things as has, say, the theory of evolution or the doctrine of the conservation of energy; or suppose the dogma of vicarious atonement pleased the mind and harmonized with our sense of the fitness of creation like the modern doctrine of embryology, namely, that embryology is a repetition of past history, that every animal in its development from the egg assumes successively, though briefly, all the forms through which its ancestors have come in the course of the long stretch of geological ages, should we not all at once accept it as true? Would there ever have been any doubters and skeptics? I think not. It is because these things have no such warrant and basis, no such agreement with our perception of the order of the world, that doubters and skeptics exist; it is because they break completely with all the rest of our knowledge of creation.

There is a very marked activity in the theological mind of to-day which has for its end the bridging over of the gulf which exists between natural and what is called "revealed" truth. Half a dozen recent works might be named of which this is the principal aim. That eloquent preacher, Frederick W. Robinson, sought in one of his sermons to give a natural basis to the dogma of vicarious sacrifice, perhaps the most incredible dogma in the popular creed. See, says the eloquent divine, how the mineral must decay before the vegetable can grow; how the vegetable must die before the animal can live; how the animal must perish before we can have roast beef for our dinner. The dove is stricken down by the hawk, the deer by the lion, the winged fish falls into the jaws of the dolphin. "It is the solemn law of vicarious sacrifice again"; and so still higher. "The anguish of the mother is the condition of the child's life." Every civilization is founded upon the labors and sufferings of those who went before. When this law of self-sacrifice is consciously obeyed it becomes the highest moral virtue and reaches heroism. Now, all this is true; it is a part of our natural knowledge. But it is not vicarious sacrifice; it is not sacrifice at all in the true sense. It is the order of the succession of life in Nature. The living present is always reared upon the dead past. Not only men, but races and nations—

> "May rise by stepping-stones of their dead selves
> To higher things."

The six noble citizens of Calais who surrendered themselves to the vengeance of the English king were offering themselves as a vicarious sacrifice. They were willing to die, that their fellows might live; but this act bears no resemblance to the order of Nature above alluded to, and from which the great preacher drew his illustration. It rises to a region of which unconscious Nature knows nothing—the region of heroism. But neither fact nor set of facts contains any hint that can lead to a rational explanation of how the death of Christ benefited mankind other than in the way the death of every hero benefits us. This is an esoteric, mysterious doctrine upon which no light can be thrown by an appeal to any known fact or law of the visible universe.

The eloquent preacher tries to help out his analogy by an original conception of Sin as "a single world-spirit, exactly as electricity, with which the universe is charged, is indivisible, imponderable, one, so that you can not separate it from the great ocean of fluid. The electric spark that slumbers in the dew-drop is part of the flood which struck the oak. Had that spark not been there, it could be demonstrated that the whole previous constitution of the universe might have been different and the oak not have been struck." Every separate act of sin is the manifestation of an original principle as broad and universal as this—the world-spirit, the spirit of evil. Grant this, and still the connection can not be made. Grant that this world-spirit slew all the prophets, opposes the good in every age, and crucified "the Just One" himself, as, of course, it did and does, how did the death of Christ modify or conquer or remove this spirit, or shield man from the supposed wrath of his Creator, in any other way than the death of every just person for a worthy cause accomplishes these ends? These are mysteries that can not be explained, or the explanation even hinted at. The human faculties of reason and insight can never fathom them. Dying that others may live is truly the order of this universe, its natural order. But what examples history affords of its having been in so many instances the conscious human order—the order which makes heroes! Even in our selfish and materialistic age, as it is called, not a year passes but our pulse is quickened by the recital of some act of heroism during some disaster upon the sea or in the mines or in burning cities, wherein men have calmly faced death that others might have a chance to live. But there is no analogy here to the popular theory of the sufferings and death of Christ. All men have to suffer the pangs of mortality just the same, and the consequences of sin just the same. When our theologians say that "Christ suffered for our sins, and that, because he suffered, our sins are forgiven," they make a statement that can not be rationally conceived; they use a language not comprehensible by human sense—the language of mysticism.

When we regard sin disinterestedly and in the light of our real knowledge, we find it but a relative term. It is not a positive thing as electricity is, but the absence of a thing, as cold is the absence of heat, or as darkness is the absence of light. It is the imperfection of human nature when tried by its highest possibilities. The theological conception of sin as imputed guilt has no more place in rational knowledge than sorcery has. The deeper our insight into the method of Nature, or the more we are impressed with the order and consistency of the world, the more incredible the popular Christianity seems to us. To the man of science the old theology is like the traditional conception of angels—men with both wings and arms.

This conception breaks with the structural plan of all vertebrates, the same as theology does with the law of cause and effect. Human beings, with wings in place of arms, might be contrary to the fact; but such a conception does not violate the homologies of Nature, but beings with both wings and arms have no counterpart in the world. They are not merely contrary to experience, they are contrary to the fundamental principle of structure that runs through the animal kingdom. But when these armed and winged beings were first conceived of, this fact was not known as it is now, and the *un*-natural element in Christianity could not have been appreciated in past ages as it is to-day.

The doctrinal part of the popular Christianity, its supernaturalism, is an inheritance from the past as much as witchcraft or magic is. But it did not break with human knowledge then; it was in strict keeping with the elements of the marvelous, and the exceptional of which human knowledge was so largely made up. There was no science in those days, no conception of the course of human or natural events as the result of immutable law. The personal point of view prevailed in everything. Everything revolved about man; superhuman beings took sides for or against him. Indeed, so far as science or a rational conception of things is concerned, the fathers of the Church, and the framers of our popular theology, were mere children. Considerations were all-powerful with them, which, to-day, would not have a feather's weight with a man of ordinary intelligence. Children readily, even eagerly, believe almost any impossible thing you may tell them about Nature. As yet they have no insight into the course of Nature, or of the law of cause and effect, no fund of experience to serve as a touchstone to the false or impossible. The same was true of the fathers, and of the races that witnessed the advent of Christianity—great in moral and spiritual matters, but mere children so far as the development of their scientific faculties were concerned; and it is from the scientific faculties that theology, as such, proceeds. Theology is an attempt to define to the understanding the basis of man's religious convictions and aspirations; it aims to be the science of God's dealings with man and Nature, and as such it is bound to share the infirmity of the logical and scientific faculty of the times in which it arises.

The contemporaries of Jesus thought it not unreasonable that John the Baptist should come to life after his head had been cut off; that the prophet Elias should reappear upon earth, or that Jeremiah should come back. These notions were in strict keeping with the belief in the marvelous and the supernatural that then possessed men's minds. The four Gospels were a growth out of this atmosphere, and the current theology is a continuation of the same faith in prodigies as opposed to natural occurrences. The fathers knew little more about the true order of the physical universe than savages. They believed, for instance, the use of the spade made the earth fertile because it was of the form of a cross; that the sun, moon, and stars shone less brightly since the fall. Irenæus gave, as his reasons for accepting the four Gospels and no more, the fact that there are four universal winds and four quarters of the earth, and because living creatures are quadriform. Origen believed that the sun, moon, and stars were living, rational beings, capable of sinning, and are subject to vanity, etc., and that they pray to the Supreme Being through his only-begotten Son. Tertullian shared the belief of his contemporaries that the hyena changes its sex every year, being alternately male and female. Clement, of Rome, believed the story of the phœnix, that wonderful bird of Arabia, which was said to live five hundred years; and when it died at the end of that time, that a worm sprang from its decaying flesh which soon became a new phœnix, which forthwith took up the bones of its defunct parent and flew away to the city of Heliopolis, in Egypt, and laid them on the altar of the sun. The natural philosopher has always taught that "death is a law and not a punishment," but "the fathers taught it is a penal infliction introduced into the world on account of the sin of Adam, which was also the cause of the appearance of all noxious plants, of all convulsions in the material globe, and, as was sometimes asserted, even of a diminution of the light of the sun." How dormant and puerile man's scientific faculties were during the early centuries of Christianity, when the foundations of the science of theology were laid, is well illustrated in a work called the "Christian Opinion concerning the World," by the monk Cosmas, of the sixth century. Cosmas taught that the earth was literally a tabernacle, because St. Paul speaks of it as such, and that Moses exactly copied its form in his tabernacle. It is a flat parallelogram, twice as long as it is broad, roofed in by the sky, which is *glued* to the outer edges of the earth. It consists of two stories, in one of which dwell the blessed, and in the other the angels, etc. It is from the type of mind that conceived such notions of the universe as this that we inherit our theology. But it may be replied, men may be feeble in science but great in religion. True, the fathers, many of them, were great in religion, they were great on the moral and spiritual side; but the system of theology they founded aims to be a science; it deals with exact propositions; it is not the work of their subjective religious natures but of their scientific faculties, and as such it is just as artificial, just as puerile and unreal, as the notions of the physical universe to which I have adverted.

The whole Christian dispensation, as expounded by the popular theology, is as little in keeping with the physical order of the world as disclosed by science, or with the natural moral order as disclosed by the conscience, as Indian medicine is in keeping with modern pathology. The whole scheme hinges upon the fall of Adam in paradise as an historical event, an act of disobedience on the part of the original progenitor of the human family, in consequence of which sin and death entered the world, and the suffering and death of Jesus became necessary to bring about a reconciliation between an angry God and rebellious man, etc.; with the attendant doctrine of the mystery of the atonement, of salvation by grace, of the eternal punishment of the pre-Christian nations, etc. Now this conception as science, or as a rational explanation of the world as it is, and of man's salvation, is on a par with Cosmas's theory of the earth with the sky glued to the outer edges. It shows the working of the same type of mind, it rests upon the same arbitrary and artificial view of things.

But, in all these matters, the question now is whether the ancient or the modern point of view shall prevail; whether evolution, or revelation, is the law of the world. The ancient point of view, as we have seen, was exclusive and arbitrary; it looked upon the universe as something *made* and governed by a being or beings external to it. In medicine, it regarded all disease as the work of evil spirits, that were to be exorcised by charms or amulets or incantations. In politics, it inculcated the divine right of kings, that the king can do no wrong, etc. In political economy, it taught that the interests of nations were mutually antagonistic and destructive of one another. In physical science, it encouraged the notions we have seen. The fathers taught that all men were under condemnation from the moment of their birth, and that at death the souls of unbaptized infants went straight to hell. St. Augustine taught, and the Catholic Church still holds, that when water from the hands of a priest falls upon the head of an unconscious infant, a miraculous change is wrought in its spiritual nature—a change by which it becomes essentially a new and a higher being; and the Church says, with characteristic charity, of him who believes not this impossible doctrine, "Let him be accursed!"

It is this type of mind which fostered alchemy, astrology, sorcery, witchcraft, and demonology. The air and the earth and the waters swarmed with spirits, good and evil; disease, pestilence, storms, and fires and floods were the work of evil spirits; the more kindly motions of Nature were the work of good spirits. A decrepit old woman could turn herself into a wolf and devour her neighbor's flocks. Meteors, eclipses, and comets were portents sent directly from Heaven for the warning of mankind.

How has all this been changed! How completely the mind of man now faces the other away, in everything except in theology—faces toward a natural explanation of all phenomena!

Let no hasty reader conclude that I am arguing against the reality of religion; I am only arguing against the reality of magic and miracles; against the conception of Christianity as a scheme for man's salvation *interpolated* into human history, and in no sense one with the constitution of the world; against the idea that the spiritual life is in no sense a possible development of man's natural capabilities; but something superadded from without, a unique and peculiar kind of life, which was made possible to man by the life and death of Christ, and in no way possible before that event. It is not an evolution from man's proper nature; it comes from the opposite direction, and is external and supplementary. "Christianity," say the Andover doctors, "is a source of knowledge concerning God which is not given by the external universe nor by the constitution of man, but only by Christ." Religion is still conceived of as a miraculous scheme to remedy some miscarriage or failure in the plan of God's dealings with man, a failure whereby his relation to the race was radically changed. It is looked upon as something naturally foreign to man, something to be ingrafted upon him from without, not related at all to his natural capacity for virtue and goodness; something which a blameless man may live and die without, but which a cut-throat during the last moments of his life upon the scaffold may, by what is called an act of faith and repentance, obtain! Against such notions I am directing my argument; I am urging that the sentiment of religion is the same in all ages and lands, differing in its outward forms, but not in its inward essence, just as the sentiment of patriotism or of loyalty is the same. How is a reasonable man to favor any scheme that rules out the religion of Plato, and Zeno, and Seneca, and Epictetus, and Cicero, and Lucretius, or Spinoza, or of Darwin, as of no avail, as only snares of Satan? The flowering of man's spiritual nature is as natural and as strict a process of evolution as the opening of a rose or a morning-glory. The vital inflorescent forces are from within, and are continuous from the root up. But there is this difference: While the plant must have a congenial environment, light, warmth, etc., the human flowering often takes place amid the most adverse surroundings; but no more so in the religious sphere than in the intellectual.

Neither would I say that the "conversion" upon which our Puritan ancestors laid such stress, and which is so dramatically illustrated in the case of Paul, was not genuine. It was genuine to them, but it was entirely a subjective phenomenon, like the faith-cures we now often hear about; it was the power of the imagination working upon the conscience. It is not a necessary or universal experience, even among religious people. It may be said without any irreverence that it has gone out of fashion. The predisposition for that kind of experience no longer exists. "The belief in witchcraft," says Milman, "made people fancy themselves witches," and the belief in the efficacy of sudden conversions led to these sorts of moral and spiritual earthquakes.

Science looks upon religion as belonging to the sphere of the natural; it is the legitimate outcome of man's moral nature; the term that best expresses the complete development and flowering of all his faculties. To define it in the guarded terms which Principal Tulloch uses, namely, as "an inner power of Divine mystery awakening the conscience," is to make it something external to man and more or less arbitrary and theological. This view the world has long clung to, but it must go—is going. The Biblical writers had no theology; the Bible is strictly a religious book, and in no sense a theological treatise. Paul developed or outlined some theological notions; but wherein was Paul great—in his theology, or in his religious fervor; in his notions of predestination, or in his aspirations after righteousness? Jesus is as free from any theological bias as a child is from metaphysics. He taught but one thing, namely, that the kingdom of heaven is in the condition of the heart, a condition illustrated by his own life. The vast and elaborate system of theology which grew up out of his parables and his Orientalism, and overshadowed the world for fifteen hundred years or more, and begat some of the darkest crimes the history of man has to show, is as far from his spirit and that of his disciples as the east is from the west.

Undoubtedly, religion knows certain things in a more intimate and personal way than science does; so does poetry, so does literature; and science can understand how this is so. What we receive through the emotions is more vital and personal to us than what reaches us through the reason. The person in whose mind has been awakened a deep love of Christ, comes to know Christ in a way the mere outside observer does not; his spirit takes hold of the Christ-idea, and is filled and modified by it to an extent the other is not. An emotional process is more potent than a rational process. The knowledge thus gained is no more truly knowledge, but it is more vital knowledge. It is not merely conviction; it is attraction and affiliation as well. But this is true not of Christ merely; it is true of the whole range of our experience. If the flower, or the bird, or the rock awaken no emotion in the observer, will he ever come truly to know it? Unless we love an author, can we ever get at his deepest and most precious meaning? Hence Goethe said, "We learn to know nothing but what we love."

In this light, science sees that the love of Christ, or of God, may transform a man's life, but not by any peculiar and supernatural process, but by a universal and well-known law, namely, that we grow like that which we love. Every object we look upon or think of with the emotion of love, that object in a measure we become. But, to begin with, we are not capable of loving it until we are in some degree, either potentially or actually, like it. No radically un-Christlike nature will ever come to love Christ. Hence the subtile truth in the old doctrines that have been so hardly and literally stated, "Except God work in you to will and to do," etc. The Christian, the virtuous, pious soul, is born, and not made, just as truly as is the poet or artist, and the "new birth," in the one case, can mean no more than it does in the other. The true Christian only gives a new name to his natural piety or aptitude for Christianity, but in no sense is there a radical change of nature. It is simply a transference of allegiance, as in the case of Paul. All these things may be so stated as to harmonize with the rest of our knowledge, but as expounded in theological books they do not so harmonize, but run counter to it completely. Subjective truths are stated as if they were objective *facts;* qualities of the mind and spirit are expounded as if they were realities of the experience.

Certain of the alleged miracles of the New Testament, as the healing of the sick by an act of faith, agree with what we now know to be true. Certain human ailments, mainly diseases of the mind and the nervous system, have in recent times undoubtedly yielded to an act of faith in the supreme efficacy of certain rites, or to an unwonted mental resolution. But the remedy is subjective and not objective. The virtue was not in the hem of the garment touched, but in the effort of the will of the person who touched it.

What is at variance with the rest of our knowledge in the New Testament are such things as grew up naturally in a superstitious age around the person and teachings of such a transcendent being as Jesus was—the notion that he was more than human, that he had no earthly father, that he had some superhuman control over the forces of Nature, that he rose from the dead, that his death bore some mysterious relation to the sins of the world, etc. When a man talks about the value and importance of the ethics of Christianity—of charity, of mercy, of justice, of gentleness, of purity, or righteousness, or of what the world has in all ages taught to be highest and best—we can understand him ; he speaks the language of truth and soberness. When he says, with Marcus Aurelius, that there is but one thing of real value—"to cultivate truth and justice, and live without anger in the midst of lying and unjust men"; or when he says with Peregrinus that "the wise man will not sin, though both gods and men should overlook the deed; for it is not through the fear of punishment or of shame that he abstains from sin : it is from the desire and obligation of what is just and good"; or when he says with Micah, "And what doth the Lord require of thee but to do justly and to love mercy, and to walk humbly with thy God?" or when he says with Solomon that "the fear of the Lord is to hate evil"; or with Jeremiah, "He judged the cause of the poor and needy—was not this to know me? saith the Lord"; or when he says with St. James, "Pure religion and undefiled before God and the Father is this, to visit the fatherless and widows in their affliction, and to keep himself unspotted from the world," he gives utterance to sentiments that appeal to the best there is in every man, and that agree with the highest wisdom of all ages and races. Science can understand it and verify it.

But when he talks to us about Jesus in the language of the evangelical churches—about the atonement, original sin, sanctification, saving grace, etc.—he simply uses a jargon that may mean something to him, but can mean nothing at all to an outsider. He states things as facts which have no ground either in reason or experience; they belong to a world apart, which neither the rest of our knowledge nor our natural faculties of reason and observation can put us in communication with. He might just as well talk about the elixir of life or of the philosopher's stone. The traditional theology has undoubtedly proved itself a good working hypothesis with crude and half-developed minds, but upon what thoughtful and cultivated person does it now make an impression? No race has been lifted out of barbarism without the aid of supernatural machinery. Once lifted out, how prone we are to discredit the machinery! We have no further use for it. We have outgrown it. But the mass of mankind are slow to outgrow it. To the mass of mankind the miraculous element of Christianity still seems vital and of first importance. Discredit that, and you have discredited religion itself in their eyes. But not so with the philosopher, or with the man who is bent on seeing and knowing things exactly as they are.

I think it is in accordance with the rest of our knowledge that Christianity could not have made its way in the world, its superior ethical and moral system could not have gained the ascendency, without the cloud of myths in which they came enveloped. What a seal of authentication is put upon it by the myth of the resurrection of Jesus! How this fact stuns and overwhelms the ordinary mind! Was it Talleyrand who replied to some enthusiast who proposed to start a new religion, that he advised him to begin by getting himself crucified, and to rise again on the third day? As a new cult founded upon reason alone, or as a natural religion alone, Christianity could not have coped with the supernatural religions that then possessed the world. Men's minds were not prepared for it, and it is probably equally true that the mass of mankind are not yet prepared for a religion based upon natural knowledge alone. But the time is surely coming, and natural science is to be the chief instrument in bringing it about. The religious sense of man is less and less dependent upon thaumaturgical aids. It is beginning to hear God in the still small voice; not in the tempest, or in the earthquake, or the fire; not in the marvelous, the extraordinary, the irrational, but in the quiet and familiar facts of Nature and of life. The vulgar mind asks for a sign, a wonder; but science has no sign, no wonder to show. It points to the simplest fact. Its relation toward the old theology is like that of Elisha toward Naaman. When Naaman came to the prophet to be cured of his leprosy, he expected Elisha to do some wonderful thing, some miracle. "Behold, I thought, He will surely come out to me, and stand, and call on the name of the Lord his God, and strike his hand over the place, and recover the leper." Instead of which the prophet simply told him to go and wash seven times in the Jordan and be clean. "My father," said his servant to the indignant Naaman, "if the prophet had bid thee do some great thing, wouldest thou not have done it? how much rather then, when he saith to thee, Wash, and be clean?"

The leprosy of the miraculous which taints men's minds is to be got rid of in the same way: wash and be clean in the current of the sweet-flowing Nature that is always near at hand, and that is always and everywhere the same.

# PRESENT STATUS OF THE GREEK QUESTION.

By EDMUND J. JAMES,

PROFESSOR OF PUBLIC FINANCE AND ADMINISTRATION IN THE UNIVERSITY OF PENNSYLVANIA.

THE recent action of the Harvard College authorities, in striking Greek from the list of studies required for the degree of A. B. marks an era in the history of college education in this country. The long struggle, which has been carried on at times with much bitterness between the classical and modern party, has been distinctly advanced one stage toward a final settlement. The adherents of the classical course have strenuously claimed for it a marked superiority over all others, and have uniformly resisted any attempt to change or supplant it. The friends of the new studies have as vigorously contended that it is perfectly possible to construct a curriculum which, while omitting some of the specific subjects before included and substituting others for them, should still as fully deserve the name liberal as the old course.

The struggle has assumed different forms at different times. At one period it was simply an attempt on the part of those who thought modern subjects worthy of recognition beside the antiquities to secure for them some place in the college curriculum. This demand, modest as it was, was resisted with the same obstinacy as that which has characterized the opposition to later and far more sweeping demands. It was a great day for American education when modern subjects, such as the natural and physical sciences, history, English and other modern languages, and social science, were finally admitted to a place in the curriculum of the colleges. It was insisted, however, that space should be found for them, not by cutting the time given to Greek and Latin, but simply by demanding more in these subjects for admission, and thus giving to them as much time as was given before and lengthening the college course correspondingly, so that a college boy is now much older than he was a half-century ago. When further demands were made with irresistible force, they were finally met by a reluctant permission to establish so-called modern or Latin-scientific or scientific courses, parallel with the old, but carrying with them a separate degree which did not recognize the candidate as a liberally educated man, whatever else he might be. It was thus that the field lay, when Dr. Eliot began fifteen years ago his career as President of Harvard College. An earnest agitation was shortly begun to make Greek elective in the course for the degree of A. B. It was maintained that the facilities for study and methods of teaching, etc., in the modern studies had been so far perfected that they could put something else in the place of Greek and still fairly claim for the man who had completed the course the proud title of bachelor of liberal arts.

Here the adherents of the old system made a desperate stand and were determined to fight the proposal to the bitter end. How far President Eliot may be personally responsible for the view within Harvard College which admitted the reasonableness of this claim of the "modernists" I am not aware. But certain it is that, whether rightly or wrongly, he is identified with it in the public mind. With every passing year, with every extension in the courses of study at Harvard, with every improvement in their facilities for giving instruction in these new branches, with every debate on the question in the faculty meetings, with every careful and unprejudiced consideration of the question in a broad or liberal way, with every increase in pedagogical knowledge; and with every comparison of our own system with that of progressive nations abroad and the tendencies of thought on educational matters elsewhere, the number of those favorable to the scheme increased, until during the last year the plan was finally adopted which marked the culmination of the long development. So fully was it recognized that Harvard's decision on the matter, if favorable to the claims of the modern party, would lend an inmense impetus to the cause everywhere and ultimately lead to the utter rout of the "ancients," that a very unusual step was taken by several of the New England college presidents. Eight of them joined in a circular memorial to the Board of Overseers of Harvard College in the spring of 1885, praying that no relaxation be made in the requisition of Greek for the A. B. I think I am right in saying that such action was unprecedented in the history of American education—the head of eight institutions of learning uniting in a request to the governing board of a ninth institution that it should not comply with the request of its faculty in regard to the course of study. It only serves to show how overwhelming the arguments in favor of such a course must have been when the prayer of such a distinguished body of clergymen as that whose names were appended to this document should have produced no visible effect whatever, except to lend additional force to the victory of the aggressive party.

The great and imperishable service which Harvard College has rendered to American education in the last fifteen years consists in two things. It has extended enormously the range of subjects in which instruction is offered within it own limits, and thereby made it absolutely necessary for all other institutions which did not wish to lag hopelessly in the rear to do the same. This necessity has produced unusual efforts in every one of these old institutions to extend its facilities. One is perfectly safe in saying that the students of every other American college of high rank owe it to-day very largely to the example of Harvard that they have in their own college far better opportunities for study than their predecessors of fifteen years ago. And the boys of to-day may largely thank Harvard for taking such a position as has resulted in bringing to them advantages which otherwise might have come only to their children.

The other service is one of equal if not of greater value, viz., the full recognition of the equivalency of different lines of study from a liberal point of view, thus practically giving force to a conviction which almost always forces itself upon one as the result of any extended study of the art and science of education. This recognition has been given in two different forms, though at bottom they are parts of one and the same general plan. It has been given by the general introduction of the elective-study system within the college itself, thus recognizing the equivalency from a liberal point of view of all lines of study, at least after the student had learned a minimum amount of Latin, Greek and mathematics, and modern languages and science. It has now gone still further, and recognizes the full equivalency of different lines of preparatory study before the student comes to the college itself. Every one who has taken the requirements for admission and studied them carefully, is surprised to learn how many different combinations may be made, all of which are recognized as equally fitting a boy to take a liberal course of study. The difference between the new list and the old is very great, and may be properly denominated as epoch-making. The most important feature, and the one which interests us most in this immediate connection, is the fact that it is now possible to make up a combination which will be accepted as satisfying all requirements but which shall contain no Greek.

I am not trying to prove that this last-mentioned feature is a good thing, though it is my personal opinion that it is good. I wish merely to call attention to the fact that Greek is finally ousted from the place which it has hitherto held in the curriculum of the oldest and most extensive center of learning on this continent, as a required subject of study.

Harvard, however, was not the first of our institutions of high rank to discard Greek from the list of its requirements for the degree of A. B. Johns Hopkins University led the way in this revolution, as in so many other good things. But its lead in the matter, owing to several circumstances, did not have anything like the same influence which Harvard's will have. In the first place, the institution had no history prior to 1876, and it was a matter which attracted but little atention when it opened, that in this regard it began at a point to which no other American institution had at that time come. It was, moreover, organized on quite a different plan from the ordinary college, and the work at first seemed to outsiders to be chiefly of post-graduate character, in which this question played but an unimportant part. Harvard, on the contrary, still retains its college form, though the spirit of the college, in the traditional sense, at least, has long since departed. Any action taken by it seems, therefore, much nearer to the average college than that of such an institution as the university at Baltimore.

Johns Hopkins allows the substitution of modern languages for Greek in the course for the degree of A. B.—i. e., it has from the first recognized the equivalency of different lines of work for the degree which crowns the course of liberal arts. The two institutions in America which, taken all in all, each in its own way, stand at the head of our educational system, join, then, in this revolutionary step. How long can the other institutions hold out along the old lines ? The fortress which the defenders of the old system have recognized as the key to the situation has fallen, it is a mere question of time how soon the others must capitulate; and we may be sure that, when they do, it will be without conditions.

If we take a glance at conditions in foreign countries, we can better understand how thoroughly in sympathy with the general progress of education in our modern world this new step is, and consequently how exceedingly sure it is of never being retraced. It is safe to say, after making all due allowances for many acknowledged defects, that the higher institutions of Germany stand as a whole at the head of similar institutions in the world. Certain it is that German educational literature leads the world. It is also certain that the educational ideals of young men in this country have been powerfully influenced by contact with German institutions. It will also be agreed that the Germans can not be accused of headlong radicalism in educational or other matters. It is worth our while, then, to notice what they are doing in this direction.

When we examine the requirements for the degree of Master of Arts, which is the German degree which corresponds most closely with our A. B., we find that not a single one of the German universities require any knowledge of Greek whatever for this degree. It is now sixteen years since the requirement of Greek for this degree and that of Ph. D. (with which the A. M. is always given) was dropped in Prussia; and although some of the German professors would like to see Greek restored to its place in the list of requirements, because it would reduce the number of students at the universities, and some others would like to see it restored for the same reasons which affect the opinion of some American educators, there is no more probability of its being restored than there is that the study of Hebrew or Sanskrit will be made compulsory.

It is a very significant fact, indeed, that the deepest students of the art and science of education in Germany are opposed to the requirement of Greek. A recent work by Professor Paulsen, of the University of Berlin, on the history of university education in Germany since the close of the middle ages, has some exceedingly significant remarks on this topic. He shows in a masterly way how prevailing ideas change in regard to the value of Greek and the proper method of its study from decade to decade. He pictures also how this language has been slowly slipping away from the position which it held fifty years ago, and how surely one can draw the conclusion as to its ultimate fate. He assigns to it, indeed, a much more subordinate place than any one here demands. He says that the course of development points to the irresistible conclusion that Greek must disappear altogether from the list of studies common in the preparatory course—must become like Sanskrit, Hebrew, Arabic, etc., a language to be studied by but few persons—chiefly those who expect to make a profession of preaching or teaching language. He recognizes certain difficulties in the way of the speedy realization of this end, most of which are not pedagogical at all, but social and political—i. e., difficulties which are entirely extraneous to the merits of the case.

The amount of Greek still required for the simple A. B. or M. A. at English or Scotch universities is ridiculously small when judged in the light of the wonderful results in the way of liberal education which are claimed for them, and there can be but little doubt that just as soon as the modern party can make itself felt and pedagogical considerations secure the weight which is now accorded only to social and political prejudice, the requirement of Greek in these pass-examinations will go the way that many other old regulations of the university have gone, which were vigorously defended by lovers of the old when they were attacked, and which would now find absolutely no apologist.

Of course, all this is independent of the merits of the question, and I have proposed simply to describe actual facts in regard to present conditions, and to call attention to what seems to be the inevitable drift of events. Very few who belong to the so-called modern party desire to belittle the study of Greek properly pursued, or would think of classing Greek in the same list as Sanskrit relative to its importance to our culture or civilization. They simply recognize the fact that life is short, and that there are many different types of intellectual ability calling for many different combinations of studies. The number of subjects of study has become so enormously large, and the value of our own literature has increased to such an extent since the time when Greek was incorporated into our school curricula, that it is now utterly idle to think of requiring Greek of all students to whom we will accord the distinction, so far as college degrees will do it, of being liberally educated.

It will not do to say that we can have a separate degree for those who have not studied Greek. The subject is no longer important enough in comparison with other studies to deserve a separate degree; and, as long as we make this distinction, we shall practically close the doors of many of our institutions to numbers of students who would otherwise be found in our academic halls. It may be said that the degree of A. B. will have no recognized value such as it has at present. It is a stretch of language to say that the degree of A. B. has in this country a recognized value in the sense in which that expression is used in this connection. Institutions of all kinds can give the degree at pleasure, and some give it to men who could not enter the freshman class at Harvard College. At any rate, it would mean something in the same sense as the German Ph. D., which is one of the most honorable of degrees, and has lost neither in dignity, or value since Greek was dropped from the list of studies required for it.

Whatever we may think of the movement, whether we favor or oppose it, it seems perfectly clear that it is bound to go forward; and, as in the case of all other great changes, those who oppose it so valiantly at present may never be converted—that is too much to expect of those whose careers are identified with the old *régime*—but they will be overruled; or, when they retire, their places will be filled with men who will wonder how their predecessors could ever have held such opinions.

## THE SUN'S HEAT.*

By Sir WILLIAM THOMSON, F. R. S.

FROM human history we know that for several thousand years the sun has been giving heat and light to the earth as at present; possibly with some considerable fluctuations, and possibly with some not very small progressive variation. The records of agriculture, and the natural history of plants and animals within the time of human history, abound with evidence that there has been no exceedingly great change in the intensity of the sun's heat and light within the last three

* Lecture on "The Probable Origin, the Total Amount, and the Possible Duration, of the Sun's Heat," delivered by Sir William Thomson, F. R. S., at the Royal Institution, on Friday, January 21, 1887.

thousand years; but for all that there may have been variations of quite as much as five or ten per cent, as we may judge from considering that the intensity of the solar radiation to the earth is six and a half per cent greater in January than in July; and neither at the equator nor in the northern or southern hemispheres has this difference been discovered by experience or general observation of any kind. But as for the mere age of the sun, irrespective of the question of uniformity, we have proof of something vastly more than three thousand years in geological history, with its irrefragable evidence of continuity of life on the earth in time past for tens of thousands, and probably for millions of years.

Here, then, we have a splendid subject for contemplation and research in natural philosophy, or physics, the science of dead matter. The sun, a mere piece of matter of the moderate dimensions which we know it to have, bounded all round by cold ether, has been doing work at the rate of four hundred and seventy-six thousand million million million horse-power for three thousand years and at possibly more, and certainly not much less, than that for a few million years. How is this to be explained? Natural philosophy can not evade the question, and no physicist who is not engaged in trying to answer it can have any other justification than that his whole working time is occupied with work on some other subject or subjects of his province by which he has more hope of being able to advance science.

I suppose I may assume that every person present knows as an established result of scientific inquiry that the sun is not a burning fire, and is merely a fluid mass cooling, with some little accession of fresh energy by meteors occasionally falling in, of very small account in comparison with the whole energy of heat which he gives out from year to year. You are also perfectly familiar with Helmholtz's form of the meteoric theory, and accept it as having the highest degree of scientific probability that can be assigned to any assumption regarding actions of prehistoric times. You understand, then, that the essential principle of the explanation is this: at some period of time, long past, the sun's initial heat was generated by the collision of pieces of matter gravitationally attracted together from distant space to build up his present mass; and shrinkage due to cooling gives, through the work done by the mutual gravitation of all parts of the shrinking mass, the vast thermal capacity in virtue of which the cooling has been, and continues to be, so slow. I assume that you have not been misled by any of your teachers who may have told you, or by any of your books in which you may have read, that the sun is becoming hotter because a gaseous mass, shrinking because it is becoming colder, becomes hotter because it shrinks.

An essential detail of Helmholtz's theory of solar heat is that the sun must be fluid, because even though given at any moment hot enough from the surface to any depth, however great, inward, to be brilliantly incandescent, the conduction of heat from within through solid matter of even the highest conducting quality known to us would not suffice to maintain the incandescence of the surface for more than a few hours, after which all would be darkness. Observation confirms this conclusion so far as the outward appearance of the sun is concerned, but does not suffice to disprove the idea which prevailed till thirty or forty years ago that the sun is a solid nucleus inclosed in a sheet of violently agitated flame. In reality the matter of the outer shell of the sun, from which the heat is radiated outward, must in cooling become denser, and so becoming unstable in its high position, must fall down, and hotter fluid from within must rush up to take its place. The tremendous currents thus continually produced in this great mass of flaming fluid constitute the province of the newly developed science of solar physics, which with its marvelous instrument of research—the spectroscope—is yearly and daily giving us more and more knowledge of the actual motions of the different ingredients, and of the splendid and all-important resulting phenomena.

Now, to form some idea of the amount of the heat which is being continually carried up to the sun's surface and radiated out into space, and of the dynamical relations between it and the solar gravitation, let us first divide that prodigious number ($476 \times 10^{21}$) of horse-power by the number ($6{\cdot}1 \times 10^{18}$) of square metres in the sun's surface, and we find 78,000 horse-power as the mechanical value of the radiation per square metre. Imagine, then, the engines of eight ironclads applied to do all their available work of, say, 10,000 horse-power each, in perpetuity driving one small paddle in a fluid contained in a square metre vat. The same heat will be given out from the square metre surface of the fluid as is given out from every square metre of the sun's surface.

But now to pass from a practically impossible combination of engines and a physically impossible paddle and fluid and containing vessel, toward a more practical combination of matter for producing the same effect : still keep the ideal vat and paddle and fluid, but place the vat on the surface of a cool, solid, homogeneous globe of the same size (${\cdot}697 \times 10^9$ metres radius) as the sun, and of density ($1{\cdot}4$) equal to the sun's density. Instead of using steam-power, let the paddle be driven by a weight descending in a pit excavated below the vat. As the simplest possible mechanism, take a long vertical shaft, with the paddle mounted on the top of it so as to turn horizontally. Let the weight be a nut working on a screw-thread on the vertical shaft, with guides to prevent the nut from turning—the screw and the guides being all absolutely frictionless. Let the pit be a metre square at its upper end, and let it be excavated quite down to the sun's center, everywhere of square horizontal section, and tapering uniformly to a point at the center. Let the weight be simply the excavated matter of the sun's mass, with merely a little clearance space between it and the four sides of the pit, and a kilometre or so cut off the lower pointed end to allow space for its descent. The mass of this weight is $326 \times 10^6$ tons. Its heaviness, three quarters of the heaviness of an equal mass at the sun's surface, is $244 \times 10^6$ tons solar surface-heaviness. Now a horse-power is 270 metre-tons, terrestrial surface heaviness, per hour; or ten metre-tons, solar surface-heaviness, per hour. To do 78,000 horse-power, or 780,000 metre-tons, solar surface-heaviness, per hour, our weight must therefore descend at the rate of one metre in 313 hours, or about twenty-eight metres per year.

To advance another step, still through impracticable mechanism, toward the practical method by which the sun's heat is produced, let the thread of the screw be of uniformly decreasing steepness from the surface downward, so that the velocity of the weight, as it is allowed to descend by the turning of the screw, shall be in simple proportion to distance from the sun's center. This will involve a uniform condensation of the material of the weight; but a condensation so exceedingly small in the course even of tens of thousands of years, that, whatever be the supposed character, metal or stone, of the weight, the elastic reaction against the condensation will be utterly imperceptible in comparison with the gravitational forces with which we are concerned. The work done per metre of descent of the top end of the weight will be just four fifths of what it was when the thread of the screw was uniform. Thus, to do the 78,000 horse-power of work, the top end of the weight must descend at the rate of thirty-five metres per year: or seventy kilometres, which is one one hundredth per cent ($\frac{1}{10000}$) of the sun's radius, per two thousand years.

Now let the whole surface of our cool solid sun be divided into squares, for example, as nearly as may be, of one square metre area each, and let the whole mass of the sun be divided into long, inverted pyramids or pointed rods, each 700,000 kilometres long, with their points meeting at the center. Let each be mounted on a screw, as already described for the long tapering weight which we first considered; and let the paddle at the top end of each screw-shaft revolve in a fluid, not now confined to a vat, but covering the whole surface of the sun to a depth of a few metres or kilometres. Arrange the viscosity of the fluid and the size of each paddle so as to let the paddle turn just so fast as to allow the top end of each pointed rod to descend at the rate of thirty-five metres per year. The whole fluid will, by the work which the paddles do in it, be made incandescent, and it will give out heat and light to just about the same amount as is actually done by the sun. If the fluid be a few thousand kilometres deep over the paddles, it would be impossible, by any of the appliances of solar physics, to see the difference between our model mechanical sun and the true sun.

Now, to do away with the last vestige of impracticable mechanism, in which the heavinesses of all parts of each long rod are supported on the thread of an ideal screw cut on a vertical shaft of ideal matter, absolutely hard and absolutely frictionless: first, go back a step to our supposition of just one such rod and screw working in a single pit excavated down to the center of the sun, and let us suppose all the rest of the sun's mass to be rigid and absolutely impervious to heat. Warm up the matter of the pyramidal rod to such a temperature that its material melts and experiences enough of Sir Humphry Davy's "repulsive motion" to keep it balanced as a fluid, without either sinking or rising from the position in which it was held by the thread of the screw. When the matter is thus held up without the screw, take away the screw or let it melt in its place. We should thus have a pit from the sun's surface to his center, of a square metre area at the surface, full of incandescent fluid, which we may suppose to be of the actual ingredients of the solar substance. This fluid, having at the first instant the temperature with which the paddle left it, would at the first instant continue radiating heat just as it did when the paddle was kept moving; but it would quickly become much cooler at its surface, and to a distance of a few metres down. Convection-currents, with their irregular whirls, would carry the cool fluid down from the surface, and bring up hotter fluid from below, but this mixing could not go on through a depth of very many metres to a sufficient degree to keep up anything approaching to the high temperature maintained by the paddle; and after a few hours or days, solidification would commence at the surface. If the solidified matter floats on the fluid at the same temperature below it, the crust would simply thicken as ice on a lake thickens in frosty weather; but if, as is more probable, solid matter, of such ingredients as the sun is composed of, sinks in the liquid when both are at the melting temperature of the substance, thin films of the upper crust would fall in, and continue falling in, until, for several metres downward, the whole mass of mixed solid and fluid becomes stiff enough (like the stiffness of paste or of mortar) to prevent the frozen film from falling down from the surface. The surface film would then quickly thicken, and in the course of a few hours or days become less than red-hot on its upper surface. The whole pit full of fluid would go on cooling with extreme slowness until, after possibly about a million million million years or so, it would be all at the same temperature as the space to which its upper end radiates.

Now, let precisely what we have been considering be done for every one of our pyramidal rods, with, however, in the first place, thin partitions of matter impervious to heat separating every pit from its four surrounding neighbors. Precisely the same series of events as we have been considering will take place in every one of the pits.

Suppose the whole complex mass to be rotating at the rate of once round in twenty-five days.

Now at the instant when the paddle stops let all the partitions be annulled, so that there shall be perfect freedom for convection-currents to flow unresisted in any direction, except so far as resisted by the viscosity of the fluid, and leave the piece of matter, which we may now call the sun, to himself. He will immediately begin showing all the phenomena known in solar physics. Of course, the observer might have to wait a few years for sun-spots, and a few quarter-centuries to discover periods of sun-spots, but they would, I think I may say, probably, all be there just as they are: because I think we may feel that it is most probable that all these actions are due to the sun's own mass and not to external influences of any kind. It is, however, quite possible, and indeed many who know most of the subject think it probable, that some of the chief phenomena due to sun-spots arise from influxes of meteoric matter circling round the sun. The energy of chemical combination is as nothing compared with the gravitational energy of shrinkage, to which the sun's activity is almost wholly due, but chemical combinations and dissociations may, as urged by Lockyer, be thoroughly potent determining influences on some of the features of non-uniformity of the brightness in the grand phenomena of sun-spots, hydrogen-flames, and corona, which make the province of solar physics. But these are questions belonging to a very splendid branch of solar science with which we are not occupied this evening.

What concerns us at present may be summarized in two propositions:

1. Gigantic convection-currents throughout the sun's liquid mass are continually maintained by fluid, slightly cooled by radiation, falling down from the surface, and hotter fluid rushing up to take its place.

2. The work done in any time by the mutual gravitation of all the parts of the fluid, as it shrinks in virtue of the lowering of its temperature, is but little less than (so little less than, that we may regard it as practically equal to*) the dynamical equivalent of the heat that is radiated from the sun in the same time.

The rate of shrinkage corresponding to the present rate of solar radiation has been proved to us, by the consideration of our dynamical model, to be thirty-five metres on the radius per year, or one ten-thousandth of its own length on the radius per two thousand years. Hence, if the solar radiation has been about the same as at present for two hundred thousand years, his radius must have been greater by one per cent two hundred thousand years ago than at present. If we wish to carry our calculations much farther back or forward than two hundred thousand years, we must reckon by differences of the reciprocal of the sun's radius, and not by differences simply of the radius, to take into account the change of density (which, for example, would be three per

* "On the Age of the Sun's Heat," by Sir William Thomson ("Macmillan's Magazine, March, 1862); and Thomson and Tait's "Natural Philosophy," second edition, vol. i, part ii, Appendix E.

cent for one per cent change of the radius). Thus the rule, easily worked out according to the principles illustrated by our mechanical model, is this :

Equal differences of the reciprocal of the radius correspond to equal quantities of heat radiated away from million of years to million of years.

Take two examples :

1. If in past time there has been as much as fifteen million times the heat radiated from the sun as is at present radiated out in one year, the solar radius must have been four times as great as at present.

2. If the sun's effective thermal capacity can be maintained by shrinkage till twenty million times the present year's amount of heat is radiated away, the sun's radius must be half what it is now. But it is to be remarked that the density which this would imply, being 11·2 times the density of water, or just about the density of lead, is probably too great to allow the free shrinkage as of a cooling gas to be still continued without obstruction through overcrowding of the molecules. It seems, therefore, most probable that we can not for the future reckon on more of solar radiation than, if so much as, twenty million times the amount at present radiated out in a year. It is also to be remarked that the greatly diminished radiating surface, at a much lower temperature, would give out annually much less heat than the sun in his present condition gives. The same considerations led Newcomb to the conclusion that "it is hardly likely that the sun can continue to give sufficient heat to support life on the earth (such life as we now are acquainted with, at least) for ten million years from the present time."

In all our calculations hitherto we have for simplicity taken the density as uniform throughout, and equal to the true mean density of the sun, being about 1·4 time the density of water, or about a fourth of the earth's mean density. In reality the density in the upper parts of the sun's mass must be something less than this, and something considerably more than this in the central parts, because of the pressure in the interior increasing to something enormously great at the center. If we knew the distribution of interior density, we could easily modify our calculations accordingly ; but it does not seem probable that the correction could, with any probable assumption as to the greatness of the density throughout a considerable proportion of the sun's interior, add more than a few million years to the past of solar heat, and what could be added to the past must be taken from the future.

In our calculations we have taken Pouillet's number for the total activity of solar radiation, which practically agrees with Herschel's. Forbes* showed the necessity for correcting the mode of allowing for atmospheric absorption used by his two predecessors in estimating the total amount of solar radiation, and he was thus led to a number 1·6

* "Edinburgh New Philosophical Journal," vol. xxxvi, 1844.

times theirs. Forty years later Langley,* in an excellently worked out consideration of the whole question of absorption by our atmosphere, of radiant heat of all wave-lengths, accepts and confirms Forbes's reasoning, and by fresh observations in very favorable circumstances on Mount Whitney, 15,000 feet above the sea-level, finds a number a little greater still than Forbes (1·7, instead of Forbes's 1·6, times Pouillet's number). Thus Langley's number expressing the quantity of heat radiated per second of time from each square centimetre of the sun's surface corresponds to 133,000 horse-power per square metre, instead of the 78,000 horse-power which we have taken, and diminishes each of our times in the ratio of 1 to 1·7. Thus, instead of Helmholtz's twenty million years, which was founded on Pouillet's estimate, we have only twelve millions, and similarly with all our other time-reckonings based on Pouillet's results. In the circumstances, and taking fully into account all possibilities of greater density in the sun's interior, and of greater or less activity of radiation in past ages, it would, I think, be exceedingly rash to assume as probable anything more than twenty million years of the sun's light in the past history of the earth, or to reckon on more than five or six million years of sunlight for time to come.

But now we come to the most interesting part of our subject—the early history of the sun. Five or ten million years ago he may have been about double his present diameter and an eighth of his present mean density, or ·175 of the density of water; but we can not, with any probability of argument or speculation, go on continuously much beyond that. We can not, however, help asking the question, What was the condition of the sun's matter before it came together and became hot? It may have been two cool solid masses, which collided with the velocity due to their mutual gravitation; or, but with enormously less of probability, it may have been two masses colliding with velocities considerably greater than the velocities due to mutual gravitation. This last supposition implies that, calling the two bodies A and B for brevity, the motion of the center of inertia of B relatively to A must, when the distances between them was great, have been directed with great exactness to pass through the center of inertia of A; such great exactness that the rotational momentum after collision was of proper amount to let the sun have his present rotational period when shrunk to his present dimensions. This exceedingly exact aiming of the one body at the other, so to speak, is, on the dry theory of probability, exceedingly improbable. On the other hand, there is certainty that the two bodies A and B at rest in space if left to themselves, undisturbed by other bodies and only influenced by their mutual gravitation, shall collide with direct impact, and therefore with no motion of their center of inertia, and no rotational momentum of the

* "On the Selective Absorption of Solar Energy," "American Journal of Science," vol. xxv, March, 1883.

compound body after the collision. Thus we see that the dry probability of collision between two of a vast number of mutually attracting bodies widely scattered through space is much greater if the bodies be all given at rest, than if they be given moving in any random directions and with any velocities considerable in comparison with the velocities which they would acquire in falling from rest into collision. In this connection it is most interesting to know from stellar astronomy, aided so splendidly as it has recently been by the spectroscope, that the relative motions of the visible stars and our sun are generally very small in comparison with the velocity (612 kilometres per second) a body would acquire in falling into the sun, and are comparable with the moderate little velocity (29·5 kilometres per second) of the earth in her orbit round the sun.

To fix the ideas, think of two cool solid globes, each of the same mean density as the earth, and of half the sun's diameter, given at rest, or nearly at rest, at a distance asunder equal to twice the earth's distance from the sun. They will fall together and collide in half a year. The collision will last for a few hours, in the course of which they will be transformed into a violently agitated incandescent fluid mass, with about eighteen million (according to the Pouillet-Helmholtz reckoning, of twenty million) years' heat ready made in it, and swelled out by this heat to possibly one and a half time, or two, or three, or four times, the sun's present diameter. If instead of being at rest initially they had had a transverse relative velocity of 1·42 kilometres per second, they would just escape collision, and would revolve in equal ellipses in a period of one year round the center of inertia, just grazing one another's surfaces every time they come round to the nearest points of their orbits.

If the initial transverse component of relative velocity be less than, but not much less than, 1·42 kilometre per second, there will be a violent grazing collision, and two bright suns, solid globes bathed in flaming fluid, will come into existence in the course of a few hours, and will commence revolving round their common center of inertia in long elliptic orbits in a period of a little less than a year. The *quasi*-tidal interaction will diminish the eccentricities of their orbits; and if continued long enough will cause the two to revolve in circular orbits round their center of inertia with a distance between their surfaces equal to ·644 of the diameter of each.

If the initial transverse component relative velocity of the two bodies were just sixty-eight metres per second, the moment of momentum, the same before and after collision, would be just equal to that of the solar system, of which seventeen eighteenths is Jupiter's and one eighteenth the sun's; the other bodies of the system being not worth considering in the account. Fragments of superficially melted solid, or splashes of fluid, sent flying away from the main compound mass could not possibly by tidal action or other resistance get into the actual orbits of the planets, whose evolution requires some finer if more complex fore-ordination than merely the existence of two masses undisturbed by any other matter in space.

I shall only say in conclusion: Assuming the sun's mass to be composed of portions which were far asunder before it was hot, the immediate antecedent to its incandescence must have been either two bodies with details differing only in proportion and densities from the cases we have been now considering as examples; or it must have been some number more than two—some finite number—at the most the number of atoms in the sun's present mass, which is a finite number as easily understood and imagined as number 3 or number 123. The immediate antecedent to incandescence may have been the whole constituents in the extreme condition of subdivision—that is to say, in the condition of separate atoms; or it may have been any smaller number of groups of atoms making up minute crystals or groups of crystals—snow-flakes of matter, as it were; or it may have been lumps of matter like this macadamizing stone; or like this stone, which you might mistake for a macadamizing stone, and which was actually traveling through space till it fell on the earth at Possil, in the neighborhood of Glasgow, on April 5, 1804; or like this—which was found in the Desert of Atacama in South America, and is believed to have fallen there from the sky—a fragment made up of iron and stone, which looks as if it had solidified from a mixture of gravel and melted iron in a place where there was very little of heaviness; or this splendidly crystallized piece of iron, a slab cut out of the celebrated aërolite of Lenarto, in Hungary;* or this wonderfully shaped specimen, a model of the Middlesburgh meteorite, kindly given me by Professor A. S. Herschel, with corrugations showing how its melted matter has been scoured off from the front part of its surface in its final rush through the earth's atmosphere when it was seen to fall on March 14, 1881, at 3.35 P. M.

For the theory of the sun it is indifferent which of these varieties of configurations of matter may have been the immediate antecedent of his incandescence, but I can never think of these material antecedents without remembering a question put to me thirty years ago by the late Bishop Ewing, Bishop of Argyll and the Isles: "Do you imagine that piece of matter to have been as it is from the beginning; to have been created as it is, or to have been as it is through all time till it fell on the earth?" I had told him that I believed the sun to be built up of stones, but he would not be satisfied till he knew, or could imagine, what kind of stones. I could not but agree with him in feeling it impossible to imagine that any one of these meteorites before you has been as it is through all time, or that the materials of the sun were like this for all time before they came together and became hot.

* The three aërolites now exhibited belong to the Hunterian Museum of the University of Glasgow, and have been kindly lent me for this evening by the curator, Dr. Young.

Surely this stone has an eventful history, but I shall not tax your patience longer by trying to trace it conjecturally. I shall only say that we can not but agree with the common opinion which regards meteorites as fragments broken from larger masses, but we can not be satisfied without trying to imagine what were the antecedents of those masses.

## CREATION OR EVOLUTION?*

By W. D. LE SUEUR.

IN a recently published work, bearing the above title, we have an elaborate plea, drawn by an eminent legal practitioner, against the doctrine of evolution as expounded by such writers as Darwin, Huxley, and Spencer. To satisfy the natural curiosity of the public as to how eminent qualifications as a jurist should have come to be united with competence for a very ambitious essay in biological and philosophical criticism, the author informs us that, for years past, he has found relaxation from severe professional labor in the study, during his leisure hours, of the works of the leading evolutionists. He believes that he has fully mastered both their facts and their reasonings; and, finding the latter very weak—so weak that, in one case, he almost blushes to have to repeat the argument to his intelligent readers—he comes forward to level the whole structure of the evolutionary philosophy, and to rebuild on its ruins the ancient theory of "special creation." It must not be supposed, however, that Mr. Curtis is indebted to previous writers for the arguments he now brings to bear in favor of that venerable position. It is over forty years, he tells us, since he looked into any of the great authorities in the department of natural theology; and he is not now conscious of having "borrowed an argument, imitated a method, or followed an example." It is not often, perhaps, that so extensive a claim can be laid to originality; for most of us, it must be confessed, borrow arguments, imitate methods, and follow examples, often to our great profit, and without, in general, feeling our consciences unduly burdened. There is no doubt in our mind that Mr. Curtis has made an honest effort to understand the writers whom he has set to work to criticise. He has conned his brief with a good deal of care; but the trouble is, as we conceive, that he has held a brief, and has not been in contact with the actual facts. He has taken one or two books of Darwin's, and one or two of Spencer's, and has subjected them to a kind of microscopic analysis; but there is no evidence whatever that either his reading or his observation has been of a character to enable him to do justice to the doctrine of evolution as a whole. He has not even read enough of the authors he criticises to

* Creation or Evolution? A Philosophical Inquiry. By George Ticknor Curtis. New York: D. Appleton and Company.

have mastered their terminology. See, for instance, his very futile and pointless criticism of the term "noumenon," as used by Mr. Spencer. Upon almost every page of his book we are made to feel that he has never really breathed the same air as the writers whose names he so continually repeats, and with whose works he professes so minute an acquaintance. He knows them simply as a counsel knows the opposite party in a suit—some one of whom he never heard before he got his instructions from his client or client's attorney, and of whom he does not want to hear any more after the trial is over.

We have tried to do justice to the extreme originality of this writer's methods, but without marked success. The patent laws of most countries, we believe, refuse to grant exclusive rights in connection with mere *processes*. A man can get a patent for a new kind of spade, but not for a new way of handling an old spade, supposing such were discoverable. Well, all we have been able to perceive in the somewhat heavy volume before us is a process, which may indeed strike the author as original with himself, but which strikes us as exceedingly familiar, and as being within very easy reach of any one whose knowledge and reasoning faculties are in a sufficiently undeveloped state to permit him to use it. It seems to consist in saying, as often as the evolutionist points to anything as exhibiting marks of relationship with anything else: "Oh, no! God made that exactly so, by a special act of creation, for wise purposes of his own." Sometimes Mr. Curtis feels sure he can indicate the purposes, and then of course the argument moves triumphantly on; at other times he acknowledges the purposes to be hidden, and then he falls back, with calm and pious assurance, on the fundamental principle that the Creator, being infinite in wisdom, must have had an infinitely wise end in view in everything that can be traced to his hand.

"All correct reasoning," says our author, "on the subject of man's descent as an animal begins, I presume, with the postulate of an Infinite Creator, having under his power all the elements and forms of matter, organized and unorganized, animate and inanimate." This declaration gives the key-note of the work, and it perhaps also affords a measure of its philosophical value. To all who are conversant with the use of philosophical terms, it will be evident that the author has but an imperfect idea of what is commonly meant by a "postulate." *He* means by it a principle which he intends to apply to the interpretation of all facts; others mean by it a principle, the non-recognition of which would render all inquiry impossible. The difference is obvious and important. In the ordinary and legitimate sense of the word "postulate," the existence of an infinite Creator can not possibly be a postulate. It may be considered either as a fact or as a theory. If it is a fact, it does not need to be postulated—it is enough to appeal to it; if it is a theory, you can not postulate it without giving it more authority than, as a theory, it ought to have. What we have to do with theories is to test them by facts, not to erect them into final and absolute standards. We do not imagine that Mr. Curtis will claim that no inquiry into man's descent can be carried on without assuming the existence of an infinite Creator, such as he describes. To such a claim, if made, the immediate and appropriate answer would be, "*Solvitur ambulando.*" Such inquiries are, in point of fact, being conducted every day, without any reference to that particular theory, simply by the aid of such facts and analogies as a study of Nature furnishes. It is quite open, of course, to Mr. Curtis to set such bounds to his own inquiries as he may approve of, and to exercise his originality to the full in devising canons of interpretation for the facts which investigation brings under his notice; but he should really not ask us to accept the special opinions by which he, as an individual, chooses to be guided, as the ultimate and indispensable conditions of all research. We are quite prepared to arrive at his opinions as the result of inquiry, if the evidence appears to be in their favor, and shall be only too happy to find ourselves in agreement with so potent a logician; but we are not prepared to "postulate" anything that is not absolutely necessary to intellectual movement.

If it should be said that Darwin himself postulated (even in the loosest sense of the word) an infinite Creator, we should meet the statement with a simple denial. Darwin expressed himself on a few occasions in language pointing to a theistic belief; but never so as to imply that the conclusions to which he might be led by a study of Nature were to be checked by general reasonings founded on the nature and attributes of an infinite Creator. One great point of difference—not to mention others—between Darwin and his present critic is that the former was profoundly conscious of his entire inability to speculate intelligently concerning what an infinite Creator might or might not, should or should not, would or would not, have done. Far from being conscious of any such inability, Mr. Curtis seems to entertain no doubt whatever of his perfect competency to discuss and settle questions as to the *probable* mode or modes of special Divine action. In one place, indeed, he admits that "we can not penetrate into his" (the Almighty's) "counsels without the aid of revelation"; but, on the very same page, he claims to be able to see sufficiently far into the purposes of God to warrant him in believing that "acts of special creation are vastly more probable than the theory of evolution." Throughout the book, indeed, we are continually being called upon to agree with the author that some particular method of action is a much more "probable" one for the Supreme Being to have adopted than some other (evolutionary) process. It does not appear to have ever struck the learned and acute author that such language may savor of impiety even to evolutionists. Where, it may very pertinently be asked, has Mr. Curtis obtained the knowledge that enables him to judge what are the probable methods of Divine action? We can understand how a man might obtain such an acquaintance with the literary or artistic style of some human author or artist, as should embolden him to pronounce an opinion as to whether a certain piece of work was or was not from the master's hand; but we do not see that any one has it in his power so to con the works of Deity as to authorize him in saying that he knows the Divine style, and is therefore in a position to decide which of two plans of action is most in harmony therewith. We have before us simply the facts that Nature presents; our task is to see these in the most rational order possible, knowing well that, however enlarged our knowledge may become, a *perfect* interpretation of the facts will forever be beyond our reach. Whatever view, therefore, may at any moment best colligate and harmonize the phenomena of the universe, that view—if we are going to concern ourselves with Divine plans—we must regard as most nearly revealing the Divine plan. But to allow our interpretation of the phenomena to be overborne and controlled by any *a priori* conceptions, such as Mr. Curtis seeks to force upon us, of the Divine nature and attributes, is simply to abandon science and betake ourselves to dogma and mysticism.

Now, to be quite frank, we don't believe Mr. Curtis is one bit better a judge of the Divine style in creation than the very humblest among us. It is puzzling enough to know how merely superior human faculties will work. The child can not understand the mind of its father in matters beyond its own experience, and can not see the wisdom of its father's actions. The inferior man can not understand the mind of the superior man. We can hardly imagine anything more ridiculous, certainly nothing more hopeless, than an attempt by weak or undeveloped minds to comprehend the workings or appraise the manifestations of minds of a higher order; yet what is the interval between the youngest child and its parent, between the most uninstructed peasant and the mightiest philosopher, compared with that existing between, say, Mr. Curtis, and that mind which he proclaims to be infinite, yet offers to interpret for us? Surely, then, it is not without good reason that the leading scientific investigators of our day have decided on conducting their researches in entire independence of all theological assumptions. They feel instinctively that the moment they begin to draw deductions from theological premises, even the most plausible, their conclusions cease to have scientific validity, and that science itself becomes a mere aborted appendage to theology.

It is time, however, to proceed to a somewhat closer examination of the work before us. The author is much struck, in the first place, with the parallel he finds existing between the Platonic theory (or rather myth) of creation as developed in the "Timæus" and the Darwinian theory of the origin of species, including the human. We fail, for our part, to see much resemblance between a myth in which everything which is referred to the arbitrary and purposive acts of an imaginary divinity, and a scientific theory which ascribes all growth and development to the unceasing operation of laws inherent (as would appear) in things themselves. What strikes us with wonder, however, is that our author, after explaining that on Plato's theory man was first made, and after him the other animals in the order of their dignity, the lowest forms of aquatic life coming last, should proceed to say that there is as much in Nature to support this view of creation as to support the Darwinian theory, according to which life, beginning with the lowliest forms, worked upward to the highest. These are his words: "Nor had Plato less of probability to support his theory than Darwin to support his. . . . If Plato had known as much about the animal kingdom as is now known, he could have arrayed the same facts in support of his theory by an argument as powerful as that which now supports the doctrine of evolution" (pp. 73, 74). This, in face of the fact that the geological record is there for every one who has eyes to read, showing that the highest forms of life were *not* first in the order of creation or development, but last, and the lowest forms first! Surely it is not the doctrine of evolution that will suffer by such an attack as this. The influence of the "postulate" must have been making itself very strongly felt when the author contrived to overlook simply the broadest, the most conspicuous, and the most important fact of all bearing on the question of the relative claims of the two theories he was comparing. It is not an encouraging example of the effect of theological or metaphysical prepossessions. The Platonic theory of the soul has also, it would seem, made much impression on our author. The Demiurgus makes it entirely "distinct from matter," and places it in some star, where it is to await the birth of the body with which it is destined to be united, and which it is to govern, if it can, "according to the eternal laws of reason and rectitude." If it succeeds in this duty, it flies back at the death of the body to its own star; if not, it passes into some more degraded body, for the purpose, apparently, of getting another chance under worse conditions. "Stripped," says the writer, "of the machinery by which Plato supposes the soul to have come into existence, his conception of its origin and its nature is the most remarkable contribution which philosophy, apart from the aid of what is called inspiration, has made to our means of speculating upon this great theme." Surely it is not our "means of speculating" upon this or any other theme that we want to have enlarged; it is our knowledge of the facts of the case; in general, the less we know the more freely we can speculate. We fail to see that as a contribution to *knowledge* the Platonic conception is of any value whatever.

The strictly scientific arguments brought by our author against the doctrine of evolution present, we feel justified in saying, no character of originality. They are such as every one in the least acquainted with the literature of the subject is thoroughly familiar with. Against Darwin is urged the absence of the intermediate forms which, upon his theory, ought to be discoverable, the apparent immutability of species, the infertility of hybrids. Whether it was worth while at this time of day to write a somewhat lengthy treatise, for the purpose of putting forward arguments so thoroughly known, is a question on which opinions may differ. We do not mean that the arguments themselves are not deserving of attention; but we do mean that they are very accessible to the reading public in a great many quarters, and are nowhere, probably, stated with greater force than in the writings of the evolutionists themselves. Such as it is, however, the scientific argumentation of this volume is interwoven throughout with argumentation of a purely theological character. The author would, possibly, call the latter philosophical; but, with every desire to be just, we think that term would be misapplied. Take the following as an example of the kind of thing we refer to: "Why depict the infinite God as a quiescent and retired spectator of the operation of certain laws he has imposed upon organized matter, when there are discoverable so many manifest reasons for the special creation of such a being as man?" Here we have Mr. Curtis talking in his usual off-hand way of the Divine Being as being swayed by "reasons," and of these reasons as being discoverable by ordinary human understanding. Have all the lessons of the Book of Job, to say nothing of the "Critique of Pure Reason," been lost upon this latest foe of evolution? It would seem so. Again we are told, in the most magisterial manner, that "in the economy of Nature, which is but another name for the economy of the Omnipotent Creator, there is no waste of power, as there is no abstention from the exercise of power, when its exertions are needed to accomplish an end." Can any one attach a rational meaning to the word "waste" as applied to that the supply of which is infinite? If we imagine, for one moment, the Creator being arraigned for something that, to finite intelligence, looked like waste, might not his reply be that he had infinite reserves of power which were not being put to any use at all? And if the finite intelligence were to rejoin that this was waste on a yet larger scale, what should we have but one more illustration of how hopeless it is for the finite mind to grapple with the infinite and absolute? Working, however, upon his double principle that the Deity never wastes power, yet is always willing to exert the full amount needed for the accomplishment of his purposes, our author is led to disbelieve entirely what the evolutionists assert in regard to the derivation of the human species from lower types of life. As he interprets the facts, the Deity *economized* power by making man on the same general plan as the rest of the mammalians, instead of drawing entirely new plans for him; and at the same time *expended* power in creating those specific differences which constitute him Man. A delicate question might here arise as to whether the various "rudiments" found in the human frame were left there through a prudent economy of power, or placed there by a wise exertion of power. We should rather Mr. Curtis would discuss the point than we; for we really can not profess to understand either the economy that could have accompanied the reduction of structures, well developed in other types to the rudimentary condition in which they are found in man, or the wisdom of producing, by a fresh exertion of power, that which was functionally useless.

Our author combats in turn nearly every position taken by Mr. Spencer in his exposition of biological evolution. To Mr. Spencer's statement that not only did no one ever see a special creation take place, but "no one ever found indirect proof of any kind that a special creation had taken place," he affirms that indirect evidence has been accumulated to an enormous extent to show that the earth is full of "special creations." If no one, he proceeds to say, ever saw a special creation take place, neither has any one ever seen an instance in which an animal of one species has been evolved out of another of a different species. Considering that the evolution of a species is conceived and uniformly represented as a process requiring multiplied generations for its accomplishment, whereas special creation, if it ever occurred before witnesses, would, we must suppose, be as observable a thing as the shooting of a meteor across the sky, the cases are not quite parallel. Of course, it is open to the creationist to say that no act of creation has taken place since man was called into being; but if so, it must be admitted that the evolutionist, who does not require to say that the processes in which *he* believes came to a stop very long ago, but who affirms, on the contrary, that the laws of evolution are just as active now as they ever were, has slightly the advantage. Moreover, the evolutionist, if he can not crowd centuries into an hour, and show the transformation of species and genera accomplishing itself before our eyes, can point to changes now in progress which, if continued through the ages, could not fail to produce the widest divergences in animal and vegetable forms. The creationist has absolutely nothing to show us that hints at or points to creation as the term is commonly understood—the flashing of something out of nothing. Mr. Curtis would fain persuade us that Shakespeare's production of "Hamlet" is an act of creation analogous, comparing small things with great, to the creation of the world. The idea is a little preposterous. Did "Hamlet" come out of nothing in any sense whatever? Was it not a special combination of ideas, experiences, imaginations, conceptions, that were part of the personality of the dramatist? And these experiences, imaginations, etc., were they not the result of the author's contact with the outer world? Are not all the words used to express even our most abstract mental operations, borrowed from the phenomena of daily life? The fact that "Hamlet" was not a creation in the theological sense is proved by the simple consideration that it was the work of the individual William Skakespeare, and came forth from his brain *as it could not have come forth from any other brain.* Why should a creation from nothing have any special character? Other things bespeak their origin in their lineaments; and, until better advised, we shall continue to think that a creation out of Nothing would look uncommonly like—Nothing. If a man born blind were, by an act of imagination or what not, to show himself quite at home in the comprehension of the phenomena of light, we should perhaps be disposed to recognize an analogy to the alleged work of creation; but we are not aware that any such achievement has been recorded. That a great thinker or poet should not always, if ever, understand how thoughts came to group themselves in his mind in any particular way is no difficulty to the evolutionist: he does not pretend to understand all the mysteries of the human organization.

One argument used by Mr. Spencer affected our author, as he tells us, very strangely. As he read he could hardly trust the evidence of his eye-sight; he thought the type must have got topsy-turvy in some strange fashion; he began to distrust the accuracy of the American edition of the philosopher's works, such an extraordinary example did he seem to have before him of "logic run riot." No doubt it was an argument that would not have told very powerfully on a jury; and that might not have brought much light even to the mind of an average judge, as it certainly has been quite lost on that of a distinguished lawyer; but the argument in our humble opinion is a good one, for all that. What Mr. Spencer says, to put it briefly, is that the idea of creation is unthinkable because it implies a relation between something and nothing. What has Mr. Curtis, after recovering from his spasm of astonishment, to say in reply? The first thing he says is that the creation of matter is not inconceivable, "if we adopt the postulate of an infinite Creator." In other words, use certain expressions that formally signify creation out of nothing, and forthwith we have the conception, clear and workable. In the same way, if we want to have the conception of a round square, we only have to say "round square," and presto, there it is! Mr. Curtis wants very badly to know who made the laws that have been "impressed upon matter"? But who knows that any laws have been "impressed upon matter"? Who knows that that is the proper way of expressing the relation between matter and its laws? Does Mr. Curtis know it? We doubt it; or rather we may say that we know that he does not *know* anything of the kind. By the so-called "laws of matter" are meant simply the properties of matter. Perhaps Mr. Curtis thinks he can conceive of matter apart from its properties, and of the properties apart from matter. Be that as it may, the question of the origin of the properties of matter is plainly a part of the question as to the origin of matter. All that Mr. Spencer says is that there is no use in talking of matter, or anything else, coming out of nothing, seeing that the words, when you press them, will be found void of meaning. When Mr. Curtis says that "the term 'creation,' as used in all modern philosophy, implies *ex vi termini*, the act of causing to exist," the answer to give is that the term "creation" is not used in "all modern philosophy," and that the idea of creation has a very small place indeed in modern philosophy. Professor Eucken, of Jena, in a useful little hand-book, which has been translated by a professor at Andover and furnished with an introduction by the ex-President of Yale, has catalogued and commented on "The Concepts of Modern Philosophy." Mr. Curtis will search the list in vain for any mention of the concept of "creation"; and it is a perfectly safe statement to make that the idea in question is not an element of any importance in contemporary philosophical thought.

Mr. Curtis says many odd things without being in the least aware of it. He describes lexicographers as "learned persons, part of whose business it is to exhibit the thought that is represented by a word, . . . according to the exact correspondence between the word and the idea which it conveys in its primary and philosophical usage." A very little reflection, aided by a small amount of inquiry, would have sufficed to satisfy him that the primary sense of a word and its philosophical sense are seldom, if ever, the same. He tells us that, according to his famous postulate, "the whole void which consists in mere nothingness" is "under the absolute sway" of the Creator. Could more nonsensical language possibly be put together? Imagine the Creator swaying "nothingness"! How much power does it take to do it? What effect has it upon "nothingness" to be "swayed"? Has it all been "swayed" yet, or is some of it still unswayed? These questions are all quite pertinent and quite absurd; and, when a question is at once pertinent and absurd, it is evident that something is wrong with the matter to which the question relates. Mr. Curtis would not believe Mr. Spencer when the latter told him that the idea of creation was unthinkable; he thought he knew better, and now we find his supposed superior knowledge leading him to represent the Almighty as *swaying nothing*. Mr. Spencer knew it would come to that; and, should he find time to look at Mr. Curtis's book, he will have no such shocks of surprise as Mr. Curtis had in reading his. Our author further tells us that "the theologian is not the only person who has occasion to examine the doctrine of evolution; it must be examined by the statesman as well." By all means! Let theologians, statesmen, and lawyers all examine it, and whosoever will let him examine it; only let this caution be whispered into each one's ear, that it requires a little preparation to examine it to any good purpose. Our author is not the only prominent lawyer who has failed to make much of it. He will find a sympathizer in Mr. Chauncey M. Depew, who told the Nineteenth Century Club, not so long ago, that, down in Wall Street, the whole phraseology of evolution would be quite unintelligible. We don't doubt it; a comprehensive system of philosophy, founded on a very wide range of induction, is apt to be incomprehensible to people who have not given it patient and prolonged study.

Our author appears to be in possession of some very definite information respecting the solar system, not set down in the ordinary treatises on astronomy. He knows that it was "arranged with reference to the law of universal gravitation," that "the existing arrangements must have been intentional," that "there is the strongest evidence that a certain means was chosen and intentionally put into operation." The Creator, however, he explains (page 183), "does not meet an external demand." He creates the demand or purpose himself and then satisfies it. What kind of "purpose" that can be that has no relation to any need the writer does not explain, though, of course, he knows. Strange to say, we read a little farther on (page 207) that the Creator is "governed by a purpose in all that he does." Does this mean that the Creator ties his own hands by the purposes that he forms without any reference to external demands? Again, we are assured with tiresome iteration that the Creator does nothing that is "useless." Useless to whom? To himself? Or to an external world? If to himself, the remark seems senseless; if to an external world, then there *is* the meeting of an external demand.

But if, on the one hand, our author knows many remarkable things that are not known to the world at large, there are other things quite within the range of his reading of which he seems to have remained willingly ignorant. He wants to know (page 214) how it came to be imposed upon a whole group of beings, as a law of Nature, that whatever utility of structure was of paramount importance to the whole group should be preserved against the modifying influences that were destined (on the theory of evolution) to produce species differing absolutely from each other." The answer is, of course, that any deviation from a structure that was of *paramount utility* would consign the organism manifesting it to destruction; and that eventually the typical organization would by age-long inheritance become so stamped into the constitution of those sharing it that a deviation of any moment would become matter of simple impossibility.

Taking the work before us as a whole, we may say that, while it evinces a creditable amount of industry on the part of its author, and while, as a piece of special pleading against the hypothesis of evolution, it shows an ingenuity that, in another sphere, must possess considerable value, it betrays an altogether insufficient acquaintance with the data on which the hypothesis in question is founded, and is, moreover, vitiated by the constant use of an assumption which Kant has abundantly shown to be an altogether illegitimate starting-point for scientific inquiry. The most serious injustice it does to the doctrine of evolution is in representing it as an irreligious system of thought. No scientific doctrine can by any possibility be irreligious, for the most that science can do is to indicate the limits of the known and the unknown. To do this is not to destroy the grounds of religion, though, as science advances, doctrinal and historical systems may have to undergo progressive modifications. It is one thing to be asked to change the form of religion, and quite another to be summoned to part with its substance. The latter demand has never, so far as we are aware, been made in the name of science by any authorized exponent. It is no new thing for religion to go forth in search of new ground. Suppose that we have now frankly to acknowledge that the old conceptions of special creation and providential design are no longer tenable in the light of modern knowledge, shall religion fail from among us? Never, unless we are willing it should fail. If we ourselves are faithful, Religion, though she may have to abide for a time in tabernacles, will still be with us, and all our thoughts and all our investigations will be hallowed by her influence. Evolution is simply the current form of scientific opinion; we adhere to it because it seems to be the truth. Religion is that instinct in man which leads him to recognize and worship that which is highest and best. Far, then, from our submission to the truth cutting us off from religion, it should, and it will, bring religion nearer to us, and enable us some day to place it upon imperishable foundations, and to make it the abiding consecration of all thought and effort.

## MEGALITHIC MONUMENTS IN SPAIN AND PORTUGAL.

By the Marquis de NADAILLAC.

NOTHING in the ancient history of man is of more considerable interest than are those monuments, at once rudely grand and mysteriously simple, which have been designated megalithic. They may be simply raised stones, isolated menhirs, cromlechs arranged in a circle, or artificial caves formed by placing flat flags horizontally on standing supports. Dolmens or covered passages were usually buried under masses of earth or stones, so as to form veritable tumuli; but they always present the common character of being constructed in rough blocks, virgin of all human labor.

Megaliths are important on account of their number * and their dispersion. They are to be found, with a likeness running through them all, in places most remote from one another, on different continents. At Carnac and at Kermarin are immense rows of stones, of

* A French sub-commission on megalithic monuments was appointed in 1879, for the purpose of assuring the preservation of the more important among these structures. An imperfect count, made under its direction, raised the number of dolmens, menhirs, polissoirs, basin-stones, and rocking-stones, still standing in France, to 6,310. Tumuli, which are very numerous, are not included in this enumeration.

which the menhirs of the Khasias of India appear like exact copies. Similar dolmens are standing in Palestine, Ireland, and Hindostan. Megaliths can be found in Peru and among the aboriginal monuments of North America, in Spain and Denmark, in the Orcades and the islands of the Mediterranean, on the shores of the Black Sea and of the Baltic, at the foot of Mount Sinai, and in Iceland at the edge of the eternal glaciers. The dolmens raised upon the top of a tumulus in Algeria may be compared with those standing in the department of the Aveyron or with those in Kintyre, Scotland, and Röskilde in Scandinavia; the cromlech of Maytura, in Iceland, with that at Halskov, in Denmark; the circle at Peshawur, in Afghanistan, with the circle of Stennis, in one of the Orcades; the tombs of the Neilgherries with the *chondets* that are found in Africa; the cromlechs of Algeria with those of Aschenrade, on the Dwina; the triliths of Stonehenge with those of Tripoli, or those mentioned by Palgrave as in Arabia. Even a superficial study will disclose the relations that exist between the covered passages of Provence and the megaliths of Brittany, and between these and analogous constructions in Spain and Algeria. A common thought, and an identical funeral rite, are revealed.

M. Cartailhac, for many years editor of the "Materiaux pour servir à l'Histoire de l'Homme" ("Materials to be used for the History of Man"), has, in a recent book on "Prehistoric Ages in Spain and Portugal" ("Les Ages préhistoriques en Espagne et en Portugal"), described some remarkable monuments in the Iberian Peninsula, most of which have not been previously brought to the scientific attention of students in other countries. The megaliths of Portugal consist in a great part of dolmens, or *antas*, as they are called there. Three hundred and fifteen of them were known in 1754. Some of them have disappeared; but though Pereira de Costa could report upon only thirty-nine at a conference held in connection with the International Exposition in Paris in 1867, Gabriel Pereira, a short time afterward, enumerated one hundred and eighteen, and these were mostly situated in the province of Beira and near Evora and Elvas, in Alemtejo.

In every country the rocks are disintegrated by the effect of weather-changes into large blocks. The megalith-builders chose those blocks for their purpose which offered the fairest surface. The inclosure was hollowed out. The stones chosen for the walls of the burial-chamber were raised, planted in the soil, and covered with large flat stones; and then the interstices were filled up with pebbles. A low, narrow entrance-gallery was made by a similar method, and, after the funeral rites were performed, the crypt was covered with a tumulus—a protecting envelope which has in most cases been removed long ago under the impulse of curiosity or with the hope of finding hidden treasures. The few dolmens still buried are called *mammoas* or *maminhas* (*mammæ*), from their peculiar form.

These antas frequently served for a considerable number of burials each, and in that case the entrance-gallery seems to have been kept open. At other times, a single corpse was deposited, and the crypt was closed, as the friends thought, forever.

Notwithstanding it has suffered considerable mutilations, the crypt of the great anta of Freixo (Fig. 1) is still standing, although the corner-stone has disappeared and the covered gallery has become dilapidated. The walls of the crypt, which is 4 metres in diameter, are composed of seven stones, 3·80 metres high, while the entrance is only 45 centimetres wide.

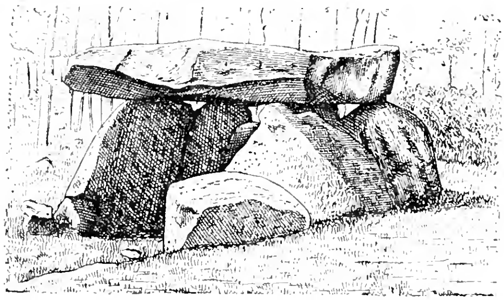

Fig. 1.—Anta of the Wood of Freixo.

Numerous antas have been explored at various times in search of the treasures which popular traditions suppose to be hidden in them; and scattered bricks, pieces of pottery, iridescent glass, and rubbish of the Roman period, testify to the energy of the diggers. The neolithic articles under the dolmens which remain unviolated are similar to those in the megaliths of the neighboring countries. The anta of Portimão has furnished hatchets, stone adzes, steatite heads, and admirably worked arrow-heads; that of Monte-Abrahão * hatchets of trap and diorite, stone scrapers, a button of bone and pearls of Caläis, that precious stone described by Pliny and remaining unknown from his time; the anta of Estria, a curious plaque of slate covered with straight or broken lines and resembling an episcopal crozier in shape; and the dolmen of Nora, besides flakes and finely cut arrow-heads, a highly ornamented ivory disk, the use of which it is hard to determine. The burial-place of Marcella (Fig. 2), a regular cromlech, is one of the richest in funeral paraphernalia. There have been collected from it, together with fine specimens of flint-flakes, retouched on the edges, and of triangular points, three vases covered with ornaments, and forty-three hatchets, nearly all of diorite, and remarkable specimens of work.

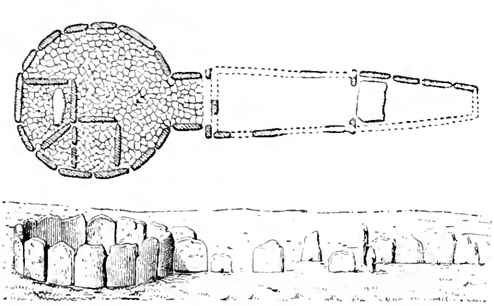

Fig. 2.—Burial-place of Marcella, Algarve—Plan and Profile View.

* Human bones, belonging to more than eighty persons of all ages and both sexes, have been collected from within this dolmen.

Some human bones lay in the midst of these memorials of human wealth. Unfortunately, they have been scattered.

We can not leave the antas of Portugal without mentioning the bowls which M. Cartailhac observed on some of the megaliths of Alemtejo. Such vessels have long been known in prehistoric archæology. They are found in Switzerland, in the Pyrenees, in Brittany, in Scotland, in Scandinavia, and on the rocks of Hindostan. The bowls, engraved on the walls of some of the crypts, recently disengaged from their earthy envelope, have doubtless, as M. Cartailhac observes in relating his discovery, an indisputable antiquity, value, and meaning; but we can not determine the age, and the value and meaning are unknown to us. Megaliths are especially abundant in Estremadura, the richest province in Roman Spain, now the most wretched and least populous. They are called *garitas* by the peasants of the province, but farther north, in the Asturias and the Basque provinces, they are known as *areas*. A most remarkable example of these works is situated at Equilaz, on the road from Vittoria to Pampeluna. The chamber is of a horseshoe-shape, 5·70 metres long and 4·50 metres wide. It was crowned by a single stone, which had been broken recently. Another, nearly similar, with an approach covered with three large flat stones, and a narrow entrance-way, is still to be seen at Caugas de Oñu, 60 kilometres from Oviedo. We also mention the megalithic sepulchres in the province of Barcelona, at Pla-Marshall, and the one near Villalba-Saserra, known as the *Pedra area*. Both of these are placed in the center of a cromlech formed of stones planted in a standing position. The ruins of the covered ways giving access to the crypt are still visible. Thirteen megalithic crypts are described as remaining in Andalusia and the ancient kingdom of Granada. The structures were formerly much more numerous; but they have been destroyed in the processes of agriculture or in the search for minerals. Such a fate has overtaken the important monument of Dilar, two leagues south of Granada.

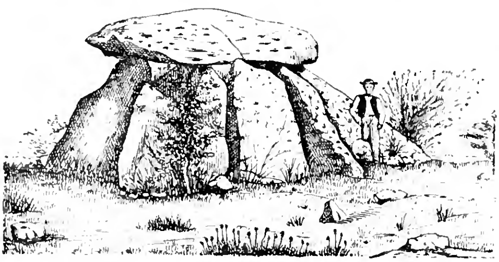

Fig. 3.—Anta of Paredes, near Evora.

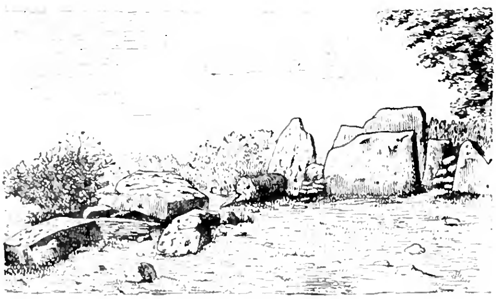

Fig. 4.—Lapa dos Moisos.

But indisputably the most remarkable megalith in Spain is the Cueva de Mengal, near the village of Antequera, province of Malaga (Figs. 5, 6, 7). The walls of the sepulchral chamber are composed

FIG. 5.—COVERED PASSAGE OF ANTEQUERA—VIEW OF THE ENTRANCE.

of twenty stones, and are crowned with five stones, while solidity is assured by setting three pillars in the interior, at the junctions of the roof-tables. Contrary to what we have hitherto observed, the stones of the walls have been rough-hewed, and those forming the pillars even

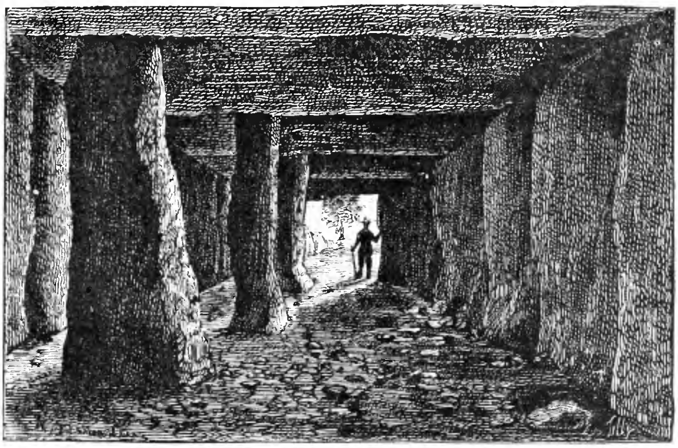

FIG. 6.—COVERED PASSAGE OF ANTEQUERA—INTERIOR VIEW.

seem to have been cut. The crypt is 24 metres long, and has a maximum breadth of 6·15 metres, and a height varying from 2·70 metres to 3 metres. It is one of the largest crypts known. The chamber of the dolmen of Pastora, farther west, beyond Seville, is 27 metres long and only 1 metre wide and 2 metres high. The excavations of Pastora have yielded thirty bronze arrow-heads.

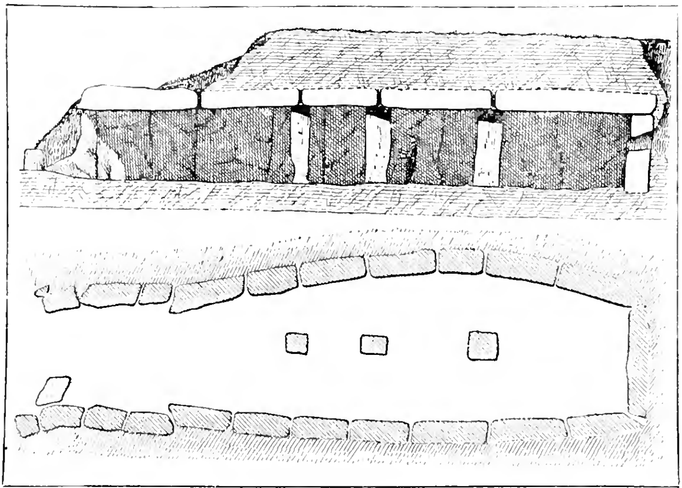

Fig. 7.—Covered Passage of Antequera—Section and Plan.

The age of the megaliths still presents an unsolved problem. It is probable that if the most ancient ones date from neolithic times, their construction was continued through many generations as an ancestral tradition; and we find them still being built when copper, and afterward when bronze, took the place of stone. There are also in Alemtejo and in the Algarves important cemeteries, in which the great crypts, covered alleys and tumuli are replaced by stone coffins measuring 2 metres long and half a metre deep. The walls are generally formed of six flags, the bottom and lid of other flags. We reproduce one of these tombs (Fig. 8), which is situated at Cerro del Castello, and probably dates from the bronze age. Another tomb, near Odemira, contains broken bones, and with them arms and utensils of stone, and an arrow-head, and a hatchet of copper, without any admixture of

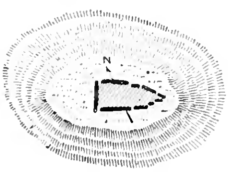

Fig. 8.—Plan of Cerro del Castello, Algarve.

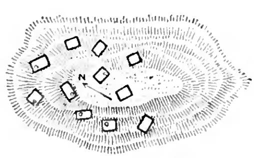

Fig. 9.—Plan of the Tombs of the Corte de Gadiana.

tin. Here we are witnesses of the transition between two distinct epochs; and, as in several other countries in Europe, pure copper is the first metal employed.

A new funeral rite responds to these new times. Incineration, imported, doubtless, by foreign conquerors, takes the place of inhumation. Cists of a reduced size (Fig. 9), urns, covered with large stones, receive the ashes, and the few fragments of bone that escape the flames, the last vestiges of that which was a man. We are touching upon the epoch when history begins. Megaliths are no longer raised in Europe. They remained for a long time an unimportant memorial of barbarous populations; and it is only in our days that they have been restored to their true place in the history of art and of human progress.—*Translated for the Popular Science Monthly from La Nature.*

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# SOCIAL SUSTENANCE.

## GENERAL PRINCIPLES AND DEFINITIONS.

By HENRY J. PHILPOTT.

THE study of the relation of organized society to individual sustenance may, for brevity, be called the science of social sustenance. This means practically the same as the term political economy in its original significance. Economy means housekeeping or husbandry, or making a living. Political economy is housekeeping as affected by social and political conditions. The word "sustenance" means making a living, with or without a house or home, and with all that the term "living" implies when used in that way. Making a living is not merely keeping body and soul together. It is supplying all the physical, moral, and mental wants, in so far as conscious, irksome effort is required to supply them. What is a living to one man is not to another; but the man who makes his own living is always called self-sustaining. *Sustenance*, therefore, is the making any kind of a living.

Social sustenance is making a living as affected by social conditions. Social conditions are the conditions brought about by the existence and conduct of other people. Exactly what social sustenance means, then, is *making a living* as affected by the existence and conduct of other people.

The study of political economy begins the moment we try to think how our making a living is affected by other people. The infinite multitude of ways in which this happens may well discourage us. But we do not have to understand all of them, nor even know all of them. We have to classify them—rudely at first, and afterward as fully as we can. The most general classification of the ways in which others affect our ability to make a living is this: 1. They may hinder us in it. 2. They may help us in it.

So it is all a question of the help and hindrance others give us in making a living. If this division into help and hindrance seems trivial, it only *seems* so, for it is not. It has to be kept in mind all the way through our study. A policy which is boasted of as enabling us to increase our mutual helpfulness, as socialism, for instance, may or it may not increase our tendency to hinder each other. If we wish to reach a right conclusion we have always to ask whether the added hindrance does not overbalance the added help. If we ignore social hindrances to individual well-being, we shall come out just where the mechanical inventor does who ignores friction.

These hindrances arise in various ways. The very existence of our fellow-beings, if in too large numbers, is a hindrance. We may denounce Malthus as much as we like, but we can not deny the awful consequences of world-crowding. Doubtless it has goaded on inventive genius, and thus promoted mutual helpfulness; but, like most social causes which work remote good, it has worked also immediate evil, and the bones of its pallid victims lie buried in the earth by countless millions. Many writers have been troubled about the matter, and especially about the future it seems to promise. Others have succeeded in convincing themselves that there is no danger, and that the denser the population the happier the individual. The truth which they distort into this error is that the evil effects of world-crowding have been partially offset, in some places more than offset, by new discoveries which cheapened production. It was not always so, and may not always be so. Certainly there are no more new continents to discover. How many new substances, or new powers and uses of old ones, are yet to discover, can not be guessed. But meantime world-crowding, the natural increase of the human species, is going on, and is constantly thrusting human beings into one another's way. We might as well face this truth as deny it, if we are going to study science. Our shrinking from a truth because it is disagreeable, unfortunately does not make it a whit less true. Up to a certain point, and it is a movable point, increase of population is beneficial. There is a certain density of population which is more desirable than any other—than any greater or any less. This movable point of most desirable density of population is moved constantly upward by the inventors who crowd the Patent-Office, by the projectors of great enterprises, and by the skillful organizers of industry; as well as by the statesmen who simplify and perfect the government, and the religious, moral, and economic teachers who facilitate adjustment of the relations of crowding and jostling human beings. As the bounds are thus extended, population grows and fills them—sometimes not quite, but alas! sometimes it quite outgrows them. Before any other explanation of the wretched condition of a community is offered, this one of population should be fully considered.

The grave question which each one asks himself as he gazes upon his own offspring, and wonders what will be the condition of their offspring some generations removed, is, Will this world-crowding relieve itself by checking reproduction as well as by stimulating mutual helpfulness; or will the time come, and how soon, when the only possible object of economic study will be to postpone the universal poverty and starvation of the human race, rather than, as now, to constantly better its condition? If a satisfactory answer to this question is possible, it has not as yet been satisfactorily rendered. But assuming the most dreaded answer to be the true one, we may still work on just the same, content to know that the greater legacy of betterment we leave them, the longer our children will be able to put off their hard fate. And besides, even in this day, we, too, find ourselves crowded out of work, or out of the market, by our needy fellow-beings, and thus hindered in trying to make our living.

But in other ways our fellow-beings hinder and shorten our sustenance. They rob us on the highway, break and plunder our inclosures, steal our purses. These are the simpler and ruder ways. They defraud us in a thousand ways. They embezzle and default. They organize gigantic schemes of plunder. And all these things necessitate laws, and governments to make and execute them, which cost immense sums of money. The Government of the United States alone costs nearly or quite as much as the annual savings of the people; though from this must be deducted the school, post-office, and other similar expenses, which would have to be paid privately if they were not paid publicly. Still, allowing one half for these purposes, the cost of government alone, to say nothing of the quarrels and crime which make it necessary, would, if saved, constitute a third of our annual savings.

But not only do (1) the existence in excess, and (2) the consciously perverse conduct of our fellow-beings hinder us in making a living; even when they do their best, the (3) awkwardness of those to whom we must delegate work which we can not do, costs us dearly every day. They bungle and blunder and delay us in an unlistable variety of ways. Our awkwardness works them the same hindrance. In this branch of the subject it would be tedious to enumerate, but fruitful to sit and think.

On the whole it is hard to say whether in our sustenance of the full measure of the life of our day we suffer most from the *existence*, or from the *wickedness*, or from the *awkwardness* of the other human beings who are trying to sustain life in the same planet, and have the same right to it as we.

Fortunately, they also help us, marvelously help us, and it remains to study how they help us. A more or less minute study of the ways in which our fellow-beings help us in making a living or achieving a sustenance, constitutes the main body of the science of political economy. Before entering on that study, it is well enough to inquire what we wish the result of their help to be. It needs not to be said that we are to help them as truly and if possible as fully as they do us. Keeping this tacitly in mind, what kind of a sustenance do we wish them to help us get? We think at once of two features which must characterize it: 1. We want it ample. 2. We want it easy.

In other words, we want as plenty as possible, and with as little work as possible. It is not merely plenty to eat and wear that we want, but in every other respect an ample living. Our tastes differ, as well as our means, in amplitude. Perfection in amplitude of means few if any of us have; but we all want it, and, failing perfection, the nearest possible approach to it.

But we like ease, too, as well as abundance. We rate these two features of our sustenance at different relative values; some of us placing a higher value on ease and others on amplitude. Some, for the sake of ease, are willing to get along without things which others are willing to work hard for. This fact must never be forgotten, for it stands in the way of many very promising schemes. In personal contact, we may have no respect for the lazy man's laziness; but, as a scientific fact, we are bound to respect it or lose our reckoning.

Laziness is, in fact, a universal characteristic, and, when not excessive, a decidedly valuable one. Whoever lacked it entirely would soon work himself to death. Work wears us out. Laziness makes us decline to wear ourselves out with work unless we see hope of a reward which will rebuild us. It leads us to calculate closely the ratio of effort to satisfaction. The establishment of that ratio, at the point of minimum effort and maximum satisfaction, is the end and aim of all human forethought. This sometimes seems not to be true. Some persons seem to have a real appetite for work. But does such an appetite ever survive the hope of a return, either to that person or to another in whom he takes an interest? No work is done excepting to amplify the sustenance, to enlarge and complete the life of some human being, or to secure for that being rest hereafter. We may work on and postpone both ease and amplitude of living indefinitely, but we always keep them both in mind as our future reward. We may think to bestow the ease upon ourselves when we shall be too old to work, and in the mean time to work and earn it. This scheme is as wise as it is natural.

We may also forego in the present some pleasures or comforts which we might enjoy, for the sake of making our old age average well with the rest of our lives in these respects. It is a pity that human beings do not all behave in this way.

It may be hastily said that the laziness or extravagance of our fellow-beings *hinders* us in making a living. But just here a careful distinction must be made. It is one thing for them to hinder us, and essentially another thing for them to fail to help us as much as they might. It is this that the sluggard and the spendthrift both do. Supposing that each barely earns whatever living he has, the spendthrift helps us most, because no one can earn an ample sustenance, whatever he afterward does with it, without helping his fellow-beings. This rule is not necessarily universal, but it applies to all civilized countries and all times. If there are any communities where human beings make a living without the help of others, and without helping others, these communities are not subjects of economic study, except as serving to illustrate the economic by reference to the uneconomic.

This leads us to the grand truth of the science, which is that, *cæteris paribus*, the better living others make, the more they help us to make ours. Not the better living they *get*, but the better living they *make*. It is not necessary to express in terms the difference between getting and making a living. A pauper does not make his living, but he gets it, notwithstanding. The same is true of people who beat their creditors. We see the difference quite plainly here. Yet if we tried to define it so that we should never have to revise our definition, we should probably be led into one of those time-wasting and brain-wasting quibbles which have been the bane of political economy. All we need do is to emphasize the word "make," when we repeat, as we can not too often repeat, that the better living others make, the more they help us to make ours; and the better living we make, the more we help others to make theirs.

There is another correlative truth, sometimes crossing and sometimes paralleling this one, that the more carefully human beings husband their means, the more they help one another in acquiring means. A careful study of the nature of capital helps us to appreciate this truth. This is not the place to enter into that study. Suffice it here to say generally that others help us most when they work and save. They help us when they only work, and they help us when they only save, but they help us most when they both work and save. And we them in like manner.

Hence it is easier to make a living in an industrious, frugal community than in a lazy, thriftless one. Hence, also, the profit to the community of the labor of convicts, paupers, and other persons in state custody. Hence the great advantage of having the world's work so divided and arranged that the weak as well as the strong can find something to do.

One other general truth, with many important special applications, must be stated here. If those who do much work, and get and squander the full reward of their labor, help us much in making a living; and if those who do much work, and, getting a good reward, save a portion of it, help us still more; those help us still more who, doing much work, are content or forced by necessity to accept a small reward. It always pays to hire a man, or trade with a man, who, considering its real worth, puts a small value upon his labor, and is satisfied with a small reward for it. Such a man may be too generous for his own good, but not for the good of those who deal with him. For, of course, the extreme limit of help in making a living which anybody could afford us would be to make it for us out-and-out gratuitously.

Undue help may cause us to relax our efforts, or to make reckless use of our opportunities, so that in the end we may be worse off; but that does not make it any the less help. We may misuse any blessing we enjoy.

But we must remember all the time that the practical object of any study of political economy or social sustenance must be, or should be, to promote the easy and ample sustenance of all, and not of some at the expense of others. Hence we desire that human helpfulness shall be not only effective but mutual. One-sided helpfulness is one of the chief evils for which we seek a remedy.

Yet we have to note carefully that the circumstance which makes our mutual help most effective may make it one-sided. We want a balance of mutual sustenance, while we help sustain one another, but we also want amplitude. We want each to have a *fair* share, but it may be that by some having more and some less than our estimate, or any estimate of a "fair" share, all will have a *larger* share. We should like it both fair and large. We can never have it either as fair or as large as we should like it. Some will always get more help than they give, and others give more than they get. And none will ever get as much as he wants.

We all agree that a proper balance of human helpfulness is desirable. We can not help agreeing that its amplitude is also desirable. The point whereon we may differ is the extent to which balance should be subordinated to amplitude, or amplitude to balance—that is, whether poverty with equality is better than wealth with inequality, the term "equality" signifying a share of sustenance to each in proportion to his services, be they much or little. So far as balance *begets* amplitude, we shall all agree theoretically, and be led by our greed to disagree practically. Each of us will always be so anxious to be sure of his share, that he will be willing to get a little more than his share.

And in this we shall always be subject to deception by appearances, as we are in all other matters. What seems to promise both abundance and equality may in practice work both impoverishment and inequality. Mastery of this deep and vital problem demands the exercise of every logical power at our command and the widest possible scope of vision.

## ORIGIN OF COMETS AND METEORS.

BY RICHARD A. PROCTOR.

THERE appeared in these pages not long since a valuable essay, by M. Daubrée, on the structure of meteorites, and a little later a very interesting paper by Professor Newton, of Yale College, in which the general question of the origin of meteors, meteorites, and comets was discussed, without any definite conclusion being indicated, except that there are objections against all the various opinions which have been expressed by Schiaparelli, Tschermak, Meunier, Daubrée, and others, respecting this very difficult subject. I should be glad if permission could be accorded to me to bring before the readers of a magazine, so high in scientific standing as "The Popular Science

Monthly," the theory to which my own researches have led me—the more so, that I find my ideas quite commonly misapprehended, insomuch that objections have been urged (as by Professor Newton and by my friend Professor Young) which, though, full of force in themselves, have no bearing whatsoever on my theory as it really is.

I may say, indeed, at the outset, that I am in thorough agreement with all or very nearly all which Professor Newton has urged in the way of objection against the views of those who have theorized on this subject on special lines, including the view (which he attributes to myself) that comets and meteors have been expelled from the sun, or from the giant planets. But, at the same time, I find in all those theories, including even the one mistakenly attributed to myself, the germs of truth. If Schiaparelli is quite mistaken in regarding comets as captured meteor-flights, we yet owe to Schiaparelli the now established theory, admitted by all (unless Mr. Denning can be counted as an exception), that meteors are closely connected with comets, and the probable theory that comets are in reality flights of meteors, though their origin in our system may not be that which Schiaparelli has assigned to them. Again, Tschermak is undoubtedly mistaken in supposing that meteorites were originally expelled from the earth's interior, yet the evidence which he has adduced to show that a certain class of meteoric bodies most probably had such an origin can not be lightly overlooked. In like manner when Daubrée speaks of meteorites as having had their origin in the stars, and regards all orders of them as telling us of stellar interiors, he unquestionably lays himself open to the objection that certain orders of meteoric bodies can not possibly have had that origin, their orbits being entirely inconsistent with any such supposition. Yet, in the work Daubrée has done to indicate the conditions under which meteorites were first formed, he has as unquestionably supplied material, of which the true theory, whatsoever it may be, must take account. So with the theory which I have been supposed to entertain. It is manifest that bodies shot forth from the sun would either return to him, or, if their velocities of ejection were great enough, would pass away not only from him, but from the solar system, forever. It is manifest, also, that the giant planets can not now possess power to expel bodies from their interior with such force as would be required for absolute rejection as distinguished from mere temporary ejection ; and certainly nothing in the present condition of our earth, or in the evidence given by her crust as to past volcanic action, suggests the likelihood, if even the possibility, that during her career as a planet she has had the power of rejecting matter from her interior.

But I have mostly found that, in endeavoring to form a true general theory on a subject of this kind, it is important to gather together the good features of the several special theories, not merely to note such weak features as become associated with them through a mistaken endeavor to make them parts of a general theory on the same scale in regard to details. A specialist, striving to generalize, nearly always goes more or less astray; but, instead of following him, even though with the idea of setting him right, it is best to take the special results he has obtained at the cost of much labor and research. If we do this with the work of all who have dealt specially with a subject, the chances are that we shall find we have gathered nearly enough to indicate a general theory, which shall include all these specially ascertained details. This the true theory, whatsoever it may be, should unquestionably do. My theory, at any rate, has been obtained in this way, and is intended in its wide generality to cover all the known facts.

So much premised, I note that my reasoning on the subject of comets and meteors starts from the idea which Professor Newton seems very properly to regard as almost necessarily true, that shooting-stars, fire-balls, aërolites, and in fine all orders of meteoric bodies, belong to the same general class, differing only *inter se* in size, distribution, orbital motion, and the proportions in which the materials constituting them are distributed. It appears to me, as it does to him, that a theory which will account for such streams as supply the August and November displays, but not for the meteoric masses which fall sporadically, can not be the true general theory of meteors; nor can any theory be accepted as at once true and general which accounts for the holosiderites while it leaves unexplained the asiderites (so called, though in reality no meteors are free from iron). Again, noting that meteors have been associated with comets, we require for any theory which shall be accepted as generally true, that while it shall explain this connection between streams of bodies producing falling stars and certain special comets, it shall also be able to account for *all* comets as possibly associated with meteor-streams, and for *all* meteor-streams as possibly associated with comets. How much resides in this last condition, those only can guess who have put the matter to the test by striving to find a general theory of comets and meteors which shall not be found to be in conflict with some fact known about particular comets or some other fact known about particular meteor systems. Yet no general theory of comets and meteors can possibly be accepted which fails when thus tested, trying though the test may be. These trying tests are, indeed, particularly valuable for the seeker after truth, seeing that they serve to diminish his field of research by fencing out portions which can not usefully be dealt with. My own experience has convinced me that negative indications serve often to lead more directly to the truth than the most seemingly decisive evidence of the positive sort, though in reality it is by combining the two kinds of evidence, rejecting because of decisive negative evidence theory after theory from among those to which we are directed by decisive positive evidence, that we can alone hope to arrive at the true theory.

With a wide choice as to a starting-point, I take first the results of M. Daubrée's analysis of meteorites in regard to chemical composition and physical structure; and I combine the positive evidence he has obtained with Professor Newton's argument—very just and of great negative weight—that no theory can reasonably be accepted with regard to meteorites which may not be extended in its general sense to all orders of meteoric bodies.

M. Daubrée tells us, then (nay, he shows by demonstrative experimental evidence), that meteorites resemble so closely in composition and structure volcanic products such as are only found deep below the earth's crust, that we may be assured they were formed under similar conditions of temperature and pressure. He constructs masses of matter under such conditions which the most experienced student of meteorites could not distinguish from true meteoric masses; and he points out how the earth in her interior laboratories has constructed and presently ejected bodies which in like manner deceived the most experienced, taking their place for a long time in museums as "the Ovifak meteorites."

M. Daubrée very naturally draws the inference that meteorites were actually formed under such conditions. But a mass formed as such volcanic products are being now formed, deep beneath the crust of the earth, could not possibly escape from such a birthplace except by such energetic extrusion as a body like our earth, now or during the ages recorded in the geologic strata, could not possibly have effected. Hence, M. Daubrée infers (again, quite naturally) that meteorites were ejected from the interiors of stars.

Applying to this result the principle indicated by Professor Newton, we see that it requires to be at once generalized and modified, for there are classes of meteoric bodies which can not possibly be regarded as coming from any of those orbs which we call stars. Among these may be specially mentioned, first, those orders of meteoric bodies which Stanislas Meunier and Tschermak have been led to regard as ejected from the earth. Without for the moment attaching any specific importance to this idea as involving a positive theory of the origin of these meteors, it is certain that the evidence adduced by Tschermak and Meunier, confirmed also by the mathematical inquiries of Sir Robert Ball, definitely negatives the idea of an origin outside the sun's special domain. In like manner we must exclude those meteor-streams which, like the Leonides, the Perseids, and the Bielids, travel in closed paths, indicating an origin within the solar system. I have myself adduced evidence which is really demonstrative, and admitted (even by those who think there *may* be some escape from it) to be for the present unanswerable, to show that these meteor-streams can not have been captured as meteor-flights by the giant planets, as Schiaparelli suggested. But, apart from this, I believe that no one who considers the nature of these streams, or the character of the orbits in which their components move, will for a moment adopt the belief that they have been ejected from the stars, even though he may accept the colorless theory (which explains nothing) that they were captured by the giant planets from out the star-depths.

Nor are we at all helped by remembering that the sun himself is a star, and that certain among the meteors which reach the earth may be supposed to have come from him. For assuredly the meteors regarded by Meunier and Tschermak as of terrestrial origin can not be attributed to the sun as their source, while the orbits of all the recognized meteor-streams are entirely inconsistent with such an origin. Mr. Matthew Williams, in his "Fuel of the Sun," has pictured bodies ejected from the sun which *somehow* come to be traveling afterward in orbits nowhere approaching within millions of miles of his surface; but no such processes are within the range of dynamical possibilities.

How, then, are we to retain at the same time what we regard as proved by Daubrée, and also those facts, inconsistent with Daubrée's theory as actually presented, which have been shown with equal certainty, either in their positive aspect (as in the case of the November and August meteor-streams) or negatively, to be certainly inconsistent with the supposed origin of meteorites from the stars? Clearly we must widen our range of survey so as to recognize an origin for meteors and meteorites which, while including Daubrée's facts, shall not exclude the others; and I think there can be very little doubt how such widening of the range of survey should be effected. Widening our survey of space will be of no service, for we only bring in more distant regions, and the meteors we have to explain require a nearer origin; but if we widen our survey of time, as assuredly we are justified in doing (for many meteorites must be millions, nay, tens, hundreds of millions of years old), we shall find other stars than those considered in Daubrée's theory, and some of these may meet our difficulty.

If there is one fact about the past of our earth and the other members of the solar system which may be regarded as certain (amid all our uncertainties in regard to the possible nebular origin of the system, or its possible origin by aggregation, or by a combination of both processes), it is that each planet began its career in a state of intense heat. I suppose no one doubts now that the giant planets retain much more of their primeval heat than the earth or Venus or Mars; nor, on the other hand, can it be reasonably doubted that the moon has parted with much more of her original heat than our earth, insomuch that, whereas, once she was the scene of such activities as we recognize in our world, she is now a cold and lifeless orb. It is in their aspect as records of the past of the planets that I note these facts. They indicate a progressive loss of heat which we only have to trace back to recognize each one of the planets, in the earliest stages of its career, as a sun-like body.

Extending, then, thus our survey in time, we find another set of stars, or rather of suns (we must now use the more general word), to be added to those regarded by Daubrée as the bodies from which meteorites (and meteors of all classes, according to Professor Newton's just generalization) have proceeded. We may in one sense, indeed, be said to have multiplied Daubrée's sun-sources of meteors manifold, since for every sun now existing in space our views as extended show a whole family of sun-like orbs. But in reality we have only strengthened our theory by the addition of the suns which once belonged to our present sun's domain, for these alone could in any way explain the meteors and meteor-streams which had prevented us from accepting stellar (or rather extra-planetary) origin for meteoric bodies. It is to be observed, however, that these suns which we now introduce into the theory were not all active at the same time. We must regard them as distributed in time much as the stars are distributed in space—some very far off, others far off, indeed, but yet *comparatively* near ; and in determining the distance of time at which they were active as suns, we can not range them in any definite order according to their mass. For instance, our own earth, though much more advanced in planetary life—that is, far cooler—than a giant planet like Jupiter, was probably in an actively sun-like state at a much more recent time : since the interval of time during which Jupiter has been cooling from the sun-like stage to his present fiery condition enormously exceeded, in all probability (owing to the vastness of his mass), the time occupied by the earth in passing from the sun-like stage through the fiery stage to her present cool and habitable condition ; and, on the other hand, though Mars is much more advanced in planetary life than the earth, yet it is quite possible (though we can form no definite opinion in this case as in the former) that Mars might have been in the sun-like stage later than the earth.

We may observe here that we not only remove from Daubrée's theory, by this extension of it, the difficulties which had before prevented us from accepting it as a general theory of the origin of meteors, but we place the theories suggested by Tschermak, Meunier, Schiaparelli, and others, in a much more satisfactory light than before. It is properly objected to Tschermak's theory, by Professor Newton and others, that our earth can not be supposed to have ever had while a world explosive energy such as that theory imagines ; but when the earth was in the sun-like state she could do all that might befit a sun. We know that our sun can eject matter from his interior with velocities sufficing to carry such matter forever away from him, for he has been caught, first by Professor Young in 1872, and several times since, in the act. What our sun with his much vaster energies can do ejectively to overcome the withdrawing power of his own much mightier mass, we may well believe that our earth in *her* sun-like days could do to overcome the attraction of her smaller mass. The only difference would be that while the sun on such occasions expels matter so as to pass forever away not only from himself but from the solar system, the earth, even in the full energy of her sun-like condition, could not probably have expelled bodies from her interior with velocity sufficing to carry them beyond the control of the sun.* The bodies ejected with velocities freeing them from the earth would thenceforward travel around the sun on orbits of different dimensions within certain limits.† Their orbits would at first intersect the earth's path, and, even under the perturbing actions of the planets, would always pass very near it, oscillating, in this respect, on either side of the earth's track so as at intervals to cross it for a while as at first. Hence there would always remain a chance of recapture, and indeed there would be a certainty that, in the fullness of time, every body ejected from the earth would be recaptured, though the fullness of time might in some cases mean many millions of years. Thus the capture of sporadic meteors of terrestrial origin would be fully accounted for.

In like manner with those streams of meteors whose orbits lie within the solar system so as to preclude the supposition that these bodies could have reached the system from without. I say definitely that the supposition is precluded, because the argument from the consideration of the laws of motion, by which I have shown that the giant planets could not possibly have captured these meteor-streams in the manner imagined by Schiaparelli, is admitted to be sound even by those who have not weighed my own theory in explanation of the origin of these systems. It is suggested by some, as by Professor Young, that there *may be some* way of explaining away the difficulty I have indicated; but I am not prepared to regard a vague suggestion of this kind as having any present weight. It seems, to say the truth, much as though one should say, for example, It has indeed been demonstrated mathematically that the circumference of a circle is not arithmetically commensurable with the diameter, but there *may* be

* It would not be absolutely impossible that some of the matter ejected from the earth in this way would pass away even from the solar system. It appears from the very existence of earth-ejected meteors, which we regard as demonstrated by Tschermak and Meunier, that she had power of ejecting matter with velocities up to seven miles per second. A velocity of little more than eight miles per second would suffice to carry matter away from the solar system if the matter chanced to be ejected from the middle of the advancing face of the earth, for then there would result *relatively to the sun* a velocity of more than twenty-six miles per second, which at the earth's distance is a velocity corresponding to parabolic motion around the sun; but this would very rarely happen.

† If we suppose our earth's eruptive power to be unable to give greater velocity of ejection than eight miles per second, then the velocities of bodies expelled from the earth would, at the distance from the sun where they began their independent careers, range between twenty-six miles and ten miles per second, the earth's orbital velocity being eighteen miles per second. Hence the orbits of the expelled bodies around the sun would range between parabolic orbits with perihelia at the earth's distance, and ellipitical orbits with aphelia at the earth's distance and perihelia at a distance of one third the earth's, with an eccentricity of ·866. None of the expelled bodies could come nearer to the sun than this last-named perihelion distance.

some way of representing the ratio of the circumference of a circle to the diameter as a fraction of some sort. The fact remains that this has been proved to be impossible; and it has equally been shown to be impossible that any flight of meteors could be captured (that is, brought into the solar domain for good) *as such*, by any planet, even by the giant Jupiter. Either the meteors must lie so very close together that their mutual attractions would make them practically one body, and keep them such after capture by the planet, which is not the case with any of the meteor-streams, or else the differences of perturbing action on the meteors would be so great that the flight must be entirely dispersed in the act of capture—not merely dispersed so as to form a stream or a larger flight, but so dispersed as no longer to form a meteor system at all.

But, extending our generalized theory to the case of the giant planets—as, be it observed, we are not only entitled but bound to do—we see that as there would be flights of meteors passing always near the earth's orbit because of their original derivation from the earth in her sun-like stage, so would there be flights of meteors passing always near the orbit of each one of the giant planets; unless, indeed, in the fullness of the vast periods of time which must have elapsed since their formation, processes such as seem to affect Encke's comet should have altered their orbits considerably. Even then they would exhibit an approach to the orbits of their parent planets such as to suggest the idea of some sort of physical association. And accordingly, we find this peculiarity so far manifested, that years before the idea ever occurred to me that any comets or meteor systems could have been expelled from the giant planets, I wrote an essay on what I called the "Comet Families of the Giant Planets," describing just such comets, though I was unable to find any interpretation at that time of the peculiarity in question.

It is worthy of notice that quite a number of difficulties, some of them very serious ones, disappear, even as these last two have done, so soon as we adopt this generalization of the special theory to which we found ourselves forced first by direct evidence.

For example, if the capture theory advanced by Schiaparelli were accepted, not only would it leave all our perplexities unexplained, not only would it involve our running directly against mathematical certainties, but it would introduce this tremendous difficulty: the number of meteor-flights traveling about in interstellar space must exceed many millions of times those which visit our solar system, and the number of such flights visiting our solar system must exceed millions of millions of times those which chanced, by a strange combination of accidents, to come within capturing distance of a planet. Again, if many of the meteor systems which cross our earth's orbit are not to be attributed to a terrestrial origin, then the number of meteor systems within the solar domain must exceed millions of millions of millions of times those which have thus been recognized. In the former case the capturing-places in the solar system are very limited in extent compared with the dimensions of the system; but in the latter case it is the whole domain of the sun which we have to compare with that mere thread of space traversed by our earth within the solar system.

I might have arrived at the same result, however, in entirely different ways—a consideration which is at once the most marked characteristic and the surest test of truth in a general theory of this sort.

Suppose, for instance, I had begun with the discovery by Professor Young that the sun has tremendous ejective might. I have shown, from the circumstances attending the formation of the eruptive prominences, that they do not indicate the ejection of glowing hydrogen and helium, but of small masses of denser matter *through* those gases. (I note, in passing, that Tacchini's observations during the last eclipse have practically demonstrated the justice of this view.) I have further proved that such masses of ejected matter have in some cases had velocities exceeding the three hundred and eighty-two miles per second which the sun can master, and therefore must have passed forever away from him. From this demonstrated fact, as surely as from M. Daubrée's demonstrated facts about meteorites, we can work out the whole theory of cometic and meteoric ejection. For our sun, being one of the stars, we may infer that what he does each star also does. Again, what he does now he must have done (perhaps once with even greater energy) during all the millions of years that he has been a sun and doing sun-work. So also must all the suns which people space, during the past millions of years of their sun-work, have expelled from time to time flights of small bodies (whose nature we have yet, so far as *this* discussion of our theory is concerned, to determine). We may conclude that from the total matter ejected at any outburst many millions of small bodies would be formed as the originally vaporous matter vomited forth condensed into the liquid form and then into the solid—perhaps quite close to the parent orb. But the total mass ejected would bear to the ejecting body some such relation as the total mass of the dust ejected at Krakatoa bore to the six hundred millions of millions of millions of tons of the earth's mass; a hundred millions of years of such ejective work from an orb like our sun might well be unable to eject a total mass from out of which such a globe as even the least of the asteroids could be formed. Moreover, what we have thus inferred about each sun during the whole of its career up to the present time, we must infer also of each one of the bodies attending on each of those suns, during the sun-like portion of the career of each such attendant orb.

Hence, taking an average meteor-flight to represent the number of bodies at each ejection, ten effective ejections per annum for each sun-like orb, an average of a million years only for the sun-like duration of each orb in space, a thousand millions of suns in our galaxy (a three-inch telescope shows a million stars), and ten orbs of various size depending (on the average) on each, then we have a grand total of $10 \times 1,000,000 \times 1,000,000,000 \times 10 = 100,000$ millions of millions of meteor flights, as representing the total number of bodies ejected from the various orbs peopling space, including those now sun-like, and also those which, though now in the fiery stage, or further advanced still in planetary life, were once as surely suns as the stars are now.

When we remember that with so many millions of millions of flights of bodies, each flight to be counted probably by millions of millions, our earth *must* from time to time be saluted by some of these, while we know that during all the years over which observation has continued, absolutely nothing has reached our earth from outside except the various orders of meteors, while no flights of bodies can be recognized as ever visiting us from interplanetary space except the various orders of comets, we are justified in concluding that *these* represent products of ejection. We infer this on the safe ground of the argument that if these bodies do not, no other bodies exist which *can* represent the product of the ejective processes we have certainly recognized. It would have been a rather bold thought, yet not wanting in reasonableness, and certainly ingenious, to have said that *therefore* comets and meteors are but different appearances of the same objects. This, though it might have been shown to be probable, could not have been shown to be certain; for the simple reason that the ejected bodies might have been only discernible when any of them entered our atmosphere, in which case only meteors would have been required by the facts or accounted for by the theory of ejection. But now that we know comets to be but flights of meteors, and meteors to be but attendants on comets, we see that one of the prettiest discoveries of modern astronomy, Schiaparelli's recognition of the connection between comets and meteors,* is implicitly associated with the results of inquiry applied to the sun's power of volcanic ejection. We might further have inferred the discoveries of Tschermak, Daubrée, Sorby, Graham, and others, as to the structure of meteorites, even though none of these bodies had ever reached our earth from interplanetary space—seeing that our earth's interior, beneath the regions now relieved by volcanic outbursts, would afford good information as to the nature of bodies ejected from such deep-seated regions of her interior, or of the interior of other celestial orbs.

A theory which could not be true except in its most generalized form, but which in that form (1) agrees with every one of the known facts, (2) accounts for many of them, (3) alone accounts for some of

* I take some pleasure in noting that I was the original proposer, and an intimate friend of mine the seconder, of the proposition that the Council of the Astronomical Society should bestow their gold medal on Signor Schiaparelli for this discovery. If we must have the prize-pig system of rewarding scientific research, let us at least, according to the good old English saying, "catch the right pig by the tail."

them, (4) shows that certain of them are its necessary consequences, would probably be right, even though it had not been yet shown that among all other possible theories there is not one which is not directly contradicted by some known facts. As, however, the general theory of the ejection of all cometic and meteoric bodies from orbs—suns of all orders, giant planets, terrestrial planets, planetoids, and moons—is as strongly supported by such negative evidence as it is by direct positive evidence, I venture to say that a case not easily shaken has been made out in its favor. No one, so far as I know, has yet indicated any objection against the theory in the generalized form in which alone I have ever advanced it. Objections have been urged against it in the form in which it has been supposed that I have maintained it. It has been very clearly shown that meteors can not come to the earth from the sun unless they strike the earth on their first course out from the central orb; it has been proved that a considerable proportion of the meteoric and cometic systems known can not have had their origin either in our sun or in any of his fellow-suns, the stars; it has been urged as effectively that the giant planets can not eject comets or meteors; and it has been shown clearly that our earth can not, in any stage of which geology has traced the records, have ejected bodies which could thenceforth travel in interplanetary space as meteors or meteor-flights. But, in these objections against specific theories of the possible origin of comets and meteors, we may find some of the strongest, if not the very strongest, arguments for that general theory to which each specific theory points, so soon as we notice that the arguments supporting each specific theory are such as decline to be limited to that theory alone.

In fine, as I suggested at the outset, if we apply to the several specific theories of comets and meteors the general principles laid down by Professor Newton, we find ourselves led irresistibly to that general theory which I have sketched above, and presented with more elaboration of detail elsewhere.

## INFLUENCE OF SNOW-MASSES ON CLIMATE.

By M. A. J. WOEIKOFF.

THE masses of snow and ice known as glaciers, which are found upon high mountains, have been the object of many studies; and it is a matter to be wondered at that the same has not been the case with the immense beds of snow that every winter cover parts of Europe, Asia, and America, to disappear in the following spring. It has perhaps been thought that the latter have less influence upon climate in general than upon other more special phenomena. But the observations that follow will tend to show that this influence exists and the subject is one well worthy to be studied.

A bed of snow covering the ground acts as a bad conductor, and renders the exchange of temperature between the surface of the ground and the lower stratum of the atmosphere slower than it would be if the snow were absent. This is a result of the porous structure of snow, the interspaces of which are filled with air. In this matter the condition of the snow is of considerable importance; the minute crystals formed by cold are poorer conductors than the larger flakes; but if the snow by alternately thawing and freezing assumes the form called *névé*, it becomes a much better conductor of heat. Farmers in countries that enjoy cold winters are well aware of the protective nature of the snow-covering, and do not fear for their grain when it is thick.

The presence of snow thus assures a higher temperature to the upper layer of the soil than it would otherwise have, and its thickness is an equally important factor with its structure. But its effect on the air is different, for it separates the air from the warmth which without its presence would escape from the ground. Snow also exercises an important influence through its power of radiation, which is dependent on its whiteness and the extent of its surface, but in which thickness is not a factor.

When air is rarefied, it contains, besides the vapor of water, only a few scattering particles of dust or smoke. Even in the tropics, snow on high mountains does not melt. Although a considerable amount of solar heat is received by the upper surface of the snow, it is all sent back into space, and the air, being very diathermanous, only retains a very small part of it. In the plain countries of high latitudes the air is not rarefied, but, when there is a large extent of snow, the other conditions are similar to those which prevail at great elevations under the tropics, particularly the absence of dust and the small quantity of aqueous vapor. The latter condition is the result of cold, while the former may arise from the fact that there is no dry bare ground near from which dust can be swept up, or from the more or less complete absence of organic life. In this case as in that of high mountains, radiation into space goes on freely, and the solar rays are without power to melt the snow so long as it preserves its light structure, and its surface does not present any dark object to absorb the rays of the sun and cause the snow around it to melt. Thus, we observe that it melts on roofs and immediately around trees, while the clear snow in the vicinity shows no signs of thawing. Snow will melt rapidly under a piece of brown paper lying in a garden; and a thin sprinkling of dust on top of snow will produce a similar effect.

We conclude, from these observations, that if a large extent of continent is covered with snow, that snow will not melt under the rays of the sun. Yet we know that the winter snows in Northern Europe, Asia, and America melt every spring and summer. How does this come about? Observations made in high latitudes show that the temperature generally remains below the point of congelation till the middle of June—that is, till a time when these latitudes receive daily a much more considerable quantity of solar heat than is received at the equator; and that frosts last there for a month or six weeks during which the sun never sets. Besides this, the solar rays are seldom intercepted by clouds, for the month of May is usually very clear in the northern regions. At Polaris Bay, latitude 81° 86′, in Northern Greenland, the sun does not set after the 11th of April, and yet, in 1872, on the 1st of June, the temperature of the air had not risen beyond the freezing-point except for ten hours on the 21st of May, while after the 2d of June the temperature was constantly above 32°; and the days during April and May were generally clear. The United States Expedition under Captain Hall passed the winter at Polaris House, latitude 78° 23′, where the sun did not set after the 20th of April. Here, again, there was no general thaw before the 31st of May, but only partial thaws on the 16th, 22d, and 27th, although the days were quite clear. On the 8th of May the sky was wholly clear for several hours, before and after noon, and the temperature was −14·4° C. at noon, and −15·1 at three o'clock in the afternoon. It was also perfectly clear on the 31st, at six o'clock in the morning and six o'clock in the evening, and the temperature did not rise above −8·8°. The observations of the Vega at Pitlekaj, near Behring Strait, in a much lower latitude, gave analogous results. We therefore see that in high northern latitudes the heat of the rays of the sun at the end of spring and the beginning of summer can not raise the temperature above the freezing-point. To what, then, shall we attribute the thaw? Probably to the winds that have passed over warmer countries, over continents, or open seas. According to the observations of the Vega, the winds came from the north till the 12th of June, and then, on the 13th, passed around to the south-southeast. These warm winds melt the upper layer of the snow; when it freezes again, it changes into *névé*, or takes on a condition less diathermanous to solar heat, in which it less readily sends back the warmth which it receives.

The melting of the snow may be speeded by the dust which the wind brings from the continental spaces whence it has already disappeared. If the warm winds do not last long enough and are not strong enough, they will not produce durable results; but a new fall of snow will give a new layer, which is only slightly diathermanous, and possesses great radiating power. As a large quantity of caloric is expended in the melting of snow, the warm winds lose much of their heat, and may thereby produce a considerable refrigerant effect. But along the frontiers of the region covered by snow, the surface of the ground, after that is nearly melted, may be warmed by the sun, and thus become a source of heat to countries farther north. The movement begins along seas that never freeze and continental spaces in which the snow never, even in winter, forms a permanent bed; it then advances more and more northward, till all the low lands of our hemisphere are (so far as we know) freed from their covering.

This advance is not continuous, but proceeds, as we might say, by leaps and bounds. Warm winds coming from the south, or from the sea, further it, but cold winds arrest it, and sometimes reduce the temperature, where the thaw has already begun, to below the freezing-point. The disappearance of the snow in all the plains of the northern hemisphere is due to the geographical conditions of the hemisphere, or because all its known parts are reached by warm, melting winds. Moreover, in some countries in high latitudes but little snow falls, so that there is not much to melt. This, however, is not always the case, for snow may be seen to cover the ground, and the temperature of the freezing-point to prevail even during the summer. The fact is not only possible, but is a reality in very high northern latitudes. We learn from observations by Sir James Ross, that on the shores of the Antarctic lands the mean temperature, even in the height of summer, is considerably below the freezing-point, and never rises above it. This is explained by geographical conditions. The shores in question are at least 20° away from all other land, and can be influenced only by the seas north of them, while it has been observed that the temperature of these seas, down to 68° of south latitude remains below the freezing-point all through the summer. The Antarctic lands, therefore, do not receive from any quarter winds which can cause a thawing of the snow; and as this remains during the summer, the rays of the sun, notwithstanding its greater nearness to the earth at that time, can not raise the temperature above this point.

The existence of a very extensive bed of snow produces another important effect which has not received the attention it deserves: it keeps the temperature at but a little distance from the freezing-point, and below it. The mean temperature in February is the same at Bogoslowsk, at the eastern base of the Ural Mountains, and at Barnaul, on the upper Obi, at the foot of the Altai Mountains. But toward the southwest, not far from the Altais, in the Kirghiz steppes, there is usually but little snow. The mean and maximum of February are therefore higher. The same difference is observed between Ustsinolsk, in the government of Vologda, and Irgirs, in the Kirghiz steppes; and analogous differences may be remarked in other places. Wherever the snow-bed is less regular, the mean and extreme maxima of temperature are higher; and the difference goes on augmenting toward the south. It is especially considerable between Mitau, near the Baltic, and Nukurs, on the lower Amou (Oxus). In February the mean temperatures of these places differ by only 0·7° C., but the mean maximum is 10·2° and the absolute maximum 11·7°. The last result is all the more striking, for it is deduced from only six years of observations, while the observations at Mitau include a space of more than forty years. An analogous result is presented in December, when the monthly means and the mean minima differ very little, but the mean maxima of Nukurs are higher by 7° and the absolute maxima by more than 10°. This is because snow rarely falls at Nukurs, and a covering lasting for several days seldom occurs. In the absence of snow there is nothing to interfere with the action of warm winds, and, in that latitude, the sun heats the ground sensibly, even in the middle of winter.

The influence of a bed of snow on the maxima should vary according as the temperature is below or above the freezing-point. In the latter case, the melting of the snow, involving the absorption of heat, would tend to prevent increase of temperature. Not only does it prevent high maxima, but it keeps the temperature near the freezing-point long after it has begun. This is why April is colder than October in Russia, Central Europe, Canada, and the Northern United States. Farther north, for the same cause, the mean temperature of May is below that of September. It can not be doubted that this cause of cold, or rather this conversion of heat into melting action, is proportional, all other things being equal, to the mass of snow that remains on the ground. Hence, in countries having cold winters, the principal obstacle to the rise of temperature in spring is found in the quantity of snow on the ground, and not in the previous cold of the winter. It is only in countries situated near the sea, or in the neighborhood of large frozen lakes, that the mean temperature of the winter has much influence on the depression of temperature in the following spring and summer, because a larger quantity of ice is found in such situations during cold seasons, and a greater sum of heat is necessary to make the melting complete than in average seasons. Snow is the only cause that can produce an analogous result in countries distant from seas and lakes. It may be concluded, from the observations on these subjects, that, at the moment when the mean temperature begins to rise above the freezing-point, everything depends upon the sum of cold existing in the form of snow and ice. The greater it is, the slower and more irregular will be the rise of temperature.

The time of the coming of the snow, its depth, and its extent, have also a very great influence on the beginning and duration of the winter frosts; and this influence is manifested, not only in the particular spot, but—in the northern hemisphere—far to the south of it. In short, we may say that snow gives duration to the cold, and prevents a rapid rise of temperature. If we knew the exact moment when a bed of snow was formed in the North in fall and winter, and if we could announce it by telegraph, we might predict the time of the freezing of rivers and canals, and thus serve the interests of vast territories—as of most of Asiatic and European Russia, Scandinavia, British America, and the United States. The announcement of the closing of rivers by ice, even if it were only four or five days in advance, would prevent the considerable losses caused by premature frosts, and permit the safe continuance of navigation during tardy winters.

In all countries where the snow forms deep masses in winter, the rivers rise at the time of its melting; the quantity of water produced by the melting of snow and ice is so great, and the evaporation is so little, as to produce much greater floods than ever can arise from rains. This phenomenon is therefore of a character to affect some of the sides of practical life; yet the way in which it operates has never been sufficiently well observed. The results of the thaw depend upon its rapidity as well as upon the quantity of snow that may be upon the ground when the frost breaks up. If the snow melts rapidly, inundations may ensue, while the duration of the high water will be too brief for it to be utilized for navigation; and the contrary will take place if the thaw is slow and gradual.

It is a popular saying in Russia that when there is little snow the waters will be high, and there will be little water when much snow falls. This kind of paradox is justified in the case of the smaller rivers. When little snow falls in winter, the ground freezes to a great depth. The first water that is spread over the surface also freezes, and a crust of ice is formed, over which the water flows as over a rock, without penetrating it. It therefore reaches the rivers quickly and swells their waters. When, on the contrary, the snow is abundant, it protects the ground in such a way that the thaw can begin from below, and the formation of a crust of ice on the surface is not possible. The melted snow penetrates the soil, and does not reach the ravines and rivers till after some time—that is, till after the ground has been saturated. The Russian peasants call this ground-water. Observation teaches that it proceeds from the forests rather than from the fields, because the snow accumulates there to a greater depth, and is less scattered by the winds than in open places.

The melting of snow from below was observed in 1884, at the Agricultural Academy of Petrovsky, near Moscow. Observations were made at the surface and at various depths down to two metres. At seventy-five centimetres the temperature reached the freezing-point on the 5th of March, and it rose to a greater height sooner from this point than at fifty or at twenty-five centimetres. As similar conditions have been observed at various points in the valley of the Volga, the high waters of that river in 1884 did not rise above the mean, notwithstanding the great depth of the snow; but the sources of the stream were so well supplied with water by the gradual melting of the snow that navigation was unimpeded during the whole of the summer and fall. The contrary took place in 1880, when a colder winter with less snow was favorable to a rapid thaw; the freshets were among the highest that had been observed, but the water soon fell off, and from August till October navigation everywhere above the mouth of the Kama was precarious.

Everything relating to the covering of the ground by snow is of such importance to science and practical life that it should be observed and published in detail. The exact moment when it occurs should be ascertained; the structure of the covering in different parts of the cold season; its depth in different places—in forests, parks, fields, and ravines; the time when it begins to melt; the advance of the thaw; the condition of the upper layer of soil under the snow (that is, whether an icy crust is formed and when), and the facts respecting high water in the rivers, should all be looked after. The business of making these observations could be intrusted to students of meteorological and phenological phenomena. The only point to be regarded as difficult is the observation of the depth of the snow under different conditions. This could be facilitated by having stakes fixed in advance, with white and red divisions clearly marked, so as to be visible from a distance. The most exact data on the mean depth of the snow will be furnished by forests, gardens, and parks, where the snow is protected against the wind by trees. In open places, numerous observations will be necessary, in consequence of the variations in the thickness of the snow, caused by the action of the wind. I believe, however, that a good observer would soon become at home, and find great interest in observations of this kind. After they have been continued systematically for a suitable time, and it has become possible to draw a few general deductions from them, telegrams might be dispatched to the central meteorological stations, reporting upon the condition of the snow. From these reports, important practical conclusions could be drawn, as in determining how long the rivers are likely to continue open to navigation, the amount of water that the rivers will have to carry after the thaw, and the probable character of the spring.

The snow-fall in the Himalayas has given rise to predictions respecting the arrival and conditions of spring in the north of India, which have been fully justified; and careful observations of this kind might be made very useful in other countries where the winters are liable to be severe.—*Translated for the Popular Science Monthly from Ciel et Terre.*

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Dr. Martineau, by way of showing up the absurdity of using what may be called "unreal words" on religious subjects, has warned the evangelicals that they can not really believe in the damnation of persons with whom they dine and joke on cordial terms; and that, if they profess to do so, the sincerity of their belief or the cordiality of their social relations must suffer. The London "Spectator" hints that it is such "unreal words," too profusely uttered by those who profess to speak with the authority of revelation, that form the best justification for the unreal words uttered by those who believe in no such authority at all.

# HYGIENE AS A BASIS OF MORALS.*

By FRANCES EMILY WHITE, M. D.,

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IN the philosophy of Fichte, that prince among German idealists, the universe of matter, so called, is reduced to ideas, and that by a method of reasoning which the ablest opponents of idealism find it difficult to refute. This, doubtless, Fichte could easily arrange, so long as his brain, digestive apparatus, etc., were in good working condition; but let a congestion of the organ of mind or of its meninges set in, and what becomes of Fichte's ideas?

*Sensibility* (by which it is meant to indicate the whole mental life, from mere consciousness to the profoundest thinking) is never manifested (so far as known) apart from a certain mechanism, the living body; and while the universe may, in the last analysis, be reduced to matter and force, these two can not be divorced—not even by a Fichte. Since, therefore, the human body is admitted to be an integrant part of the universe of matter, its various activities must be included in the general category of forces. If, then, it be conceded that the body and mind of man hold to each other the same relations which exist between other aggregations of matter and their associated energies, the physician, though he minister to the body only, becomes thereby the high-priest of humanity, contributing to its noblest ends.

But in the parting words which it is my privilege to address to you (upon whom has just been conferred the responsible and honored title of Doctor of Medicine), I desire to point out a yet more excellent way in the pursuit of which you may indeed become the benefactors of mankind. The art of exterminating disease does not exist; and, although the death-rate varies in different localities and in the same locality under varying conditions, so far as recorded, no disease, once originated, has ever wholly disappeared; and while we may take a justifiable satisfaction in the advances made in the rational treatment of the sufferer from disease, the sources of disease (except so far as bacteriology gives promise in this direction) have not been disturbed, either by the progress in general civilization or by the great development of medical science and art. Both the experience of the past and modern scientific observation, then, alike point—not in the direction of the extirpation or even of the cure of actual disease—but rather in that of *preventive medicine or hygiene* as presenting the most hopeful field for future work. Not that I would undervalue the efforts of the profession toward the relief of suffering when disease actually exists—a most important and beneficent part of its work—but, just as exer-

* Address delivered at the thirty-fifth annual commencement.

tions for the release of an unfortunate inmate of Moyamensing are of less significance than the institution of measures calculated to reduce the number of commitments, so the application of means for the prevention of disease is of far higher value than effort in the direction of mere relief.

It is not, however, with the view of the prevention of physical suffering alone that I desire to commend to you the sphere of preventive medicine. My main thesis introduces us to a far higher and broader region of thought—viz., to a consideration of the *moral* value of preventive medicine. In presenting this subject I shall endeavor to show that hygiene is the *basis of morals*, and this from the two following points of view: 1. That whatever promotes the physical well-being of the individual and of the community, promotes also their moral well-being. 2. That the tendency of disease is to undermine morality.

The hygienic value of moral living (a proposition the exact converse of that just stated) has long been recognized. Even its curative influence has not been overlooked. In that charming story, "Little Lord Fauntleroy," the author is true to the universal experience in depicting the improvement in health of the unfeeling old earl which follows upon the springing up in his heart of a true affection for his young grandson and heir. In this new unfolding of sympathetic interests, he gradually forgets the twinges of gout which have heretofore made life a burden; and, thus neglected, the disease languishes —or rather, the new tide of life which courses through his weakened veins gradually sweeps away the ashes which have accumulated around his miserable joints—and he again mounts his horse and rides forth into the life-renewing air and sunshine, tempted to the effort by the winning companionship of the loving and tender-hearted young philanthropist. The returns of moral well-doing in the guise of physical well-being have, indeed, ever been held up as an incentive to morality, from that remote time when length of days was promised as the reward of filial piety, to those modern exhortations to honesty and virtue embodied in the mercenary maxims of the shrewd Ben Franklin. But the idea that hygienic living is the real basis of moral living has scarcely been hinted at, except by the few leaders in this department of thought among whom alone a science of morals is definitely recognized.

It would be idle to claim that society can be regenerated by a scientific formula, however profound; but, if the future progress of the race can be said to depend on the application of any one principle —if the field of rational effort toward this end may be illuminated by any one conception—it is this one of the dependence of morality upon the observance, both public and private, of the principles of health. This claim (which may be regarded by some as a fanciful one) is based upon the penetrating character and universal applicability of the principle—penetrating and universal, because founded in the very laws of our being.

It will scarcely be denied that the most highly civilized races and nations are also, on the whole, the most distinguished for morality, and that the stage of progress of a people at any given period may be fairly estimated by the character of the moral code then prevailing. This is so well understood that illustration is unnecessary. It then follows that the development of morality is inseparable from the general progress. But the degree of civilization of a people at any given stage is determined by the nature of its environment—i. e., by the conditions under whose influence the nation has developed. It has been pointed out by a distinguished philosopher in literature and art, Professor Taine, that "the profound differences which exist between the German races on the one hand, and the Greeks and Latins on the other, have arisen, for the most part, from the differences between the countries in which they are settled"—for social conditions are determined primarily by organic or bodily conditions—these, in turn, depending on the physical environment. Thus, the general sources of organic life must be recognized as the sources also of morals ; and the emotional, intellectual, and moral nature of man as an integrant part of his physical organism : being such, these higher qualities are necessarily modified by the conditions which influence and modify the physical organism.

A distinguished English sanitarian, Mr. Edwin Chadwick, has said that he could build a city which would give any desired death-rate from fifty or any number higher than fifty, to five or perhaps even less than five in a thousand, annually ; and the President of the Health Department of the British Social Science Association, at the annual meeting in 1875, expressed his unqualified confidence in the feasibility of Mr. Chadwick's proposition. This means nothing less than that the death-rate, within these wide limits, from five or less to fifty or more per thousand annually, depends on the degree of attention paid to certain public sanitary regulations.

Side by side with this proposition, I venture (and with a degree of confidence not less than that of Mr. Chadwick) to place another proposition far more radical than his, viz., that a city might be so built, and the municipality so administered, as to secure *any desired degree of morality* within certain limits. That these limits can not, at present, be as exactly defined as in the case of the death-rate, results from the lack of systematic study of the subject of morals, and the consequent want of complete statistics in this department of sociology. The nature of the limits may, however, be designated ; and I beg to illustrate this point by reference to the principles of animal development, of which it has been said, by Professor Du Bois-Reymond, that "the laws of organic structure must account for whatever, in organisms, is either useless or actually disadvantageous"—natural selection accounting for whatever is positively useful. In other words, two principles are recognized as determining the character of animal forms: 1. Natural selection, which implies the production of such structures as are useful in the particular environments in which the animal is placed. 2. The influence of the structure already acquired at any given period of development—this being determined by heredity. But heredity itself represents the organized product of a permanent environment, as illustrated, for example, in the hereditary blindness of fishes living in Mammoth Cave; or, better still, in the respiratory mechanism of all water-breathing animals; so that the environment is the ultimate factor which determines the specific character of animal forms—the structure developing slowly in accordance with this influence.

Similarly in the department of morals, two factors must be recognized as determining conduct: 1. Those qualities of character belonging by inheritance to the organized structure of body and brain. 2. Those influences which grow out of the social environment, which are constantly modifying the inherited nature, and building up a corresponding character. In my proposition, then, to found a city in which any given degree of morality, within certain limits, may be secured, these limits are understood to depend on the laws of inherited character; while the modifiable morality (that which may or may not be secured at the option of the founder of the city) is that which depends on the particular environment, physical and social, determined upon by the founder; the inherited character, also, like the inherited bodily organism, being subject to modification from this source. To discuss this proposition in a manner commensurate with its importance, would take us too far afield for the present occasion, since it would involve a consideration of the whole subject of the origin and evolution of morals. Your attention is, therefore, invited to a few only, and those the more obvious, points connected with this proposition of securing a given morality-rate within certain limits, inherently as definable, although not as precisely defined, as in the case of the proposition with reference to the mortality-rate.

As a result of Mr. Chadwick's statement, Dr. B. W. Richardson (in the address referred to) projected a city of health, which he named Hygeia (and which it is scarcely necessary to premise was located in Spain!) in which all the modern sanitary inventions and precautions, calculated either to promote health or to prevent disease, were grouped together in a picture most delightful to the mind's eye of every sanitarian. This model city, Hygeia, with some alterations and additions, would furnish the material substratum of the possible city of which I have spoken, and which I would name *Ethica*. A brief glance at the general features of our model will serve to bring the subject fairly before us.

First, and most conspicuously, we note that overcrowding in this city of health is impossible—made so by the style and location of the houses, which secure an equal distribution of the population fixed, at the time of building, at one hundred thousand people, domiciled in twenty thousand houses, which are scattered over an area of four thousand acres. Crowded alleys in the immediate rear of streets lined with spacious dwellings are wholly avoided; neither are tall structures, overshadowing the streets (a veritable shadow of death), anywhere permitted, four stories, aggregating sixty feet in height, being the limit with which all must comply. Every house has its foundations on solid arches of brick, through which air freely flows, and down whose slopes all currents of water are carried away—this arrangement preventing the entrance of ground-air into the house—an unavoidable mischief in the present style of architecture, the air of all our houses being more or less contaminated from this source. When the soil, naturally impure from the presence of carbonic-acid gas, is honeycombed, as in this city, with cesspools, and saturated with leakage from sewer-pipes, gas-pipes, and the soakings of filth-laden streets, the danger of contamination of houses from ground-air assumes considerable importance.

The liberal extent of territory occupied by our model city allows room for several broad boulevards, which constitute the chief thoroughfares, beneath each of which is a railway operated by electricity, where the heavy traffic of the city is carried on; while all the streets are so broad as to be always thoroughly ventilated, and at times flooded with sunlight. In the city of Hygeia, as described by its projector, the streets run from east to west and from north to south, as in this, our own favored town; but in the founding of *Ethica*, while keeping to the right-angled plan (though at a considerable sacrifice of artistic effect), I would choose the diagonals of these directions as tending to secure a more equal distribution of sunlight to both sides of the streets, and to all sides of the houses; since in at least one European city the death-rate has been found uniformly higher on the shady side than on the sunny side of the streets. All the open spaces in the rear of the houses are occupied as gardens, and all public buildings, including warehouses, stables, etc., are surrounded with gardens or open lawns, which add no less to the beauty than to the health of the city. The streets are paved, not exactly with gold, but with something equally impermeable to moisture, and far more agreeable to the eye, hence more conducive to comfort and health—a material comparatively noiseless and as susceptible of a clean sweep as Philadelphia at the last election. At present, concrete combines these qualities in a higher degree than any other material thus far employed, but even this leaves much to be desired, and there is room for invention in this direction. Surface-railways are not permitted in Hygeia, the underground roads being regarded as sufficient for all purposes; but in the proposed city of *Ethica*, underground roads will be used for merchandise only; passenger-railways will be elevated, thus reducing to a minimum the number of employés compelled to spend their working-hours underground. These structures will be made unobjectionable by setting apart the space necessary for them, and by using electricity as the motor power. The sidewalks, paved with a gray-stone, most agreeable to the eye, slope gently toward the streets, where they meet a like gentle inclination of the streets from their centers; and by means of side-openings into the adjacent subways, which underlie the houses, the street washings and sweepings, reduced to a minimum by the abolition of street-railways, and the banishment of all traffic to the underground roads, are daily removed with the sewage; the streets are thus kept uniformly clean and dry, and the gutter being conspicuous by its absence, as the garden by its presence, the Kindergarten supersedes the *Kinder-gutter* in this scheme of civilization.

Underground rooms do not exist; hence there is no burrowing of human beings in dark and loathsome cellars, such as may be found in most large cities. The style of architecture does not admit even of basement-kitchens, where hundreds of our domestic classes spend the greater part of their lives, as effectually buried as are the laborers in a coal-mine. On the contrary, the living-part of every house begins on a level with the street, so that every room inhales the pure outside air and drinks in the liquid sunlight.

On the subject of the water-supply I hesitate to speak. At this season of the year, especially, it may be considered unwise to stir up the mental *subsidence-basin*, which must exist in the mind of every thoughtful member of this particular community; but, as this is an important feature of our model city, it calls for emphatic notice. First of all, the water is described as free from sewage or other refuse—a matter that might be supposed to go without saying, in the case of water used for drinking, were it not for the unhappy experience of more than one city which has outgrown the original source of its supply. This water, though free from all avoidable sources of contamination, is nevertheless carefully filtered before admission to the city pipes. It is also tested daily, and, if found in any degree unsatisfactory, is still further purified by the transmission through it of ozone, generated for this and other disinfecting purposes. The water, thus doubly protected, is distributed freely to every house through iron pipes, pipes of lead being strictly forbidden.

In the contemplated city of Ethica I would introduce the system of electric lighting for private as well as public uses; not only on account of its hygienic superiority, but also for its indirect moral influence, since crime lurks in darkness, and the flooding of the streets of any city at midnight with the brightness of noonday must inevitably reduce the percentage of crime, which is, to a certain extent, a matter of opportunity. The prayer, "Lead us not into temptation," is a recognition of the importance of this principle.

Radical changes in the houses appear in connection with the chimneys, the roofs, the kitchens, and their adjoining offices, for the particulars of which I refer those interested to Dr. Richardson's address, as well as for plans for the warming and ventilation of the houses, and for the safe and effectual sewering of the city; also for most important suggestions in regard to public laundries and the carrying on of certain industries (dress-making, tailoring, etc.) in the homes among the children of those engaged in such work. In connection with the last-named point, the author cites an instance as having come under his own observation, in which the half-made riding-habit, destined to figure among the fashionable frequenters of Rotten Row, was made to serve as a coverlet for the poor tailor's child, stricken with malignant scarlet fever—an incident eminently likely to occur under our present system, or want of system, of sanitation—the dangers from public laundries, as at present managed, being equally conspicuous.

It will be seen that no expense is to be spared in the building and administration of the city of Ethica. Money is abundant in the favored country of its location; the vast sums also which are expended in other cities in the support of almshouses, penitentiaries, jails, and other places of detention of incapables and criminals, are largely saved to the public treasury. As a matter of economy merely these methods would pay the best in the end, not only in the results which we have especially in view, but in actual eagles, dollars, dimes, and cents. In the State of Pennsylvania alone there are, in round numbers, five thousand insane and five thousand feeble-minded persons, who constitute a heavy burden upon the community. Those who understand the true nature of many of the causes of idiocy and insanity know that both are, to a great degree, as strictly preventable as are small-pox and diphtheria.

In that startling record of a criminal family—"the Jukes"—covering the history of several generations, it is estimated that a loss of over a million and a quarter of dollars was caused by this single family, so far as its members could be traced, without including the money expended for intoxicants, and without taking into account the entailment of pauperism and crime, or the incurable disease, idiocy and insanity growing out of these unwholesome lives—all of which bring heavy expense upon the public. But it is clearly shown in this history that the perpetuation of criminal tendencies, as of other traits, depends on the *permanence of the environment*, and that a change of external conditions may, in time, bring about a change in character. Do our laws, our courts, our jails, our almshouses, our insane hospitals, our schools and churches even, deal with the real questions presented in these statistics? Is not an exact and scientific treatment of the subject of morals, in its entire breadth and fullness, emphatically demanded; and will not the city of Ethica, when it shall arise, prove an economy in every sense of that so-often falsely used word?

But, in the pursuit of the twofold object for which Ethica is to be founded, the intelligent co-operation of all its citizens will be essential to the full success of the experiment. To this end, special instruction in methods of personal hygiene and the hygiene of the house will be given to all, while the training of experts in public sanitation will be provided for by the public. On account of his special acquaintance with the principles of physiology and their hygienic applications, the physician will naturally become the teacher of the people in these matters, thus acting the part of a reformer in the best sense of that much-abused word, since he is the true representative of modern science as applied to the art of living in a manner alone worthy of human beings.

The moral training of children will make a part of the daily education of all their faculties, by methods which conform, in a general way, with Froebel's system. Public instruction in practical methods of moral training of children will also be provided for parents, who may not themselves have experienced the advantages of such training, and who may not fully realize that the foundations of the moral character, as of the physical health, are laid in early infancy and childhood.

To the necromancer of old was attributed the power of subverting the forces of Nature and setting her laws at defiance; but modern science has realized the pretensions of these charlatans, not by defying but by investigating the laws of Nature, and she has not only read the secrets of the stars in her magic mirror, but has penetrated to the hidden sources of human character; and while recognizing the constraining influence of external conditions in human development, she also discerns the power of human invention, human energy, and, above all, human sympathy in modifying the environment, not only by subduing the natural forces, but by directing and controlling social conditions. Under the guiding star of science, human nature reacts upon Nature, remolding her forms and redirecting her forces in accordance with its own desires and needs.

But the triumph of the scientific method is, as yet, far from complete; and not until a science of morals is as definitely recognized as a science of eclipses, or of any physical phenomenon whatever, can the era of science be said to have more than begun. When she shall have mastered the principles of morals, as she already has the principles of physics, and when the science of morals, thus formulated, shall have become an *applied* science, then real progress in morals will be assured, and will be as much more rapid than it has hitherto been, as the advance in physical science in these modern times has surpassed the slow growth of the pre-scientific era.

The doctrine that morality is to a certain degree subordinate to the physical status, though contrary to commonly received views, is evidently true. The opium-inebriate is abnormally egoistic, unsympathetic, untruthful, in short, *immoral;* the alcohol-inebriate is morally as well as physically weak and often cruel; as it has been forcibly expressed, "Alcohol reduces its subject first to a child, then to a brute."

Its effects, if long-continued, are to pauperize and permanently brutalize, just in proportion as it induces physical deterioration; and none so well as the pathologist knows the extent of the organic degeneration which accompanies and underlies the moral degradation—which is, in fact, the *corpus delicti*, the very substance and body of the offense. Hence the descent to *Avernus* by this route is not only easy, but, once fully inaugurated, the return becomes difficult if not impossible. *Hoc opus est, hoc labor est.** Such a traveler burns his bridges in crossing them, and, the physical basis of moral living being destroyed, the full restoration of the superstructure becomes a physiological and hence a moral impossibility. For the benefit of those whose thoughts are trained to run in curves—to whom a temperature-chart represents the condensed eloquence of a whole chapter of description—the statement may be made that in one of the few series of exact observations in this direction the curve of alcoholic expenditure was found to be followed by the curve of arrests for crime of all kinds, even more closely than by the curve of arrests for drunkenness; showing, to a demonstration, that the crime-stage does not always wait for the drunken-stage—that the slow and silent deterioration due to alcoholic drinks is not necessarily dependent on their *excessive* use. But from that most instructive history of the Jukes, already cited, it appears that certain physical and mental disorders often precede the appetite for stimulants, and that the real cause of their use, in a large proportion of cases, is antecedent physical exhaustion, either hereditary or acquired. Both the prevention of constitutional disease and its cure (if such a thing be possible) will then do much toward the prevention of inebriety and the crimes and lesser immoralities which grow out of it. Disease is the equivalent of weakness, and induces not only physical indifference but moral apathy. Dr. Bruce Thompson, Surgeon to the General Prison of Scotland, says: "In all my experience, I have never seen such an accumulation of morbid appearances as in the autopsies of the prisoners who die here. Almost every organ of the body is more or less diseased; and their moral nature seems equally diseased with their physical frame."

The intimate relationship between nervous diseases and crime is conspicuous. In England, the ratio of insane to sane criminals is thirty-four times as great as of the insane to the whole population, and criminal lunatics are in excess in the high proporton of seventeen to one.†

The statistics of insane hospitals in our own country show that insanity, in a large proportion of cases, is associated with unhygienic living—both overwork and want of work, as well as monotony of work, being fruitful of this kind of degeneracy. A considerable percentage of the insane women in our hospitals is drawn from country farms. The monotonous drudgery of their daily lives, and the little

* This is the need, in this is the work.

† "Book of Health," Malcolm Morris.

time for reading or other means of rescue from mental torpor, are among the causes of loss of mental balance.

Dr. Elisha Harris, Corresponding Secretary of the Prison Association of New York, who has made a special study of the criminal classes, says that habitual criminals spring almost exclusively from degenerating stock. Thus, physiological unsoundness is moral decay. The inference is obvious, and the remedy for criminality from this source *stares us in the face.* Hygienic methods of living, which, with judicious medical precautions and care, tend toward the prevention of physical degeneration, will tend in an equal ratio to lessen the number of candidates for criminal careers.

The correctional discipline which is sought after (if not found) in our reformatories and prisons, is not only vastly more expensive, but far less satisfactory, than would be the application of preventive measures.

Professor Ferris, in a paper on the hygiene of schools,* says: "I can not recall ever having visited a room occupied by forty or fifty pupils that could be said to be properly ventilated; and, under the influence of impure air, study is irksome and good behavior difficult." Thus in our very schools the seeds of physical deterioration and moral degeneracy are sown in the tender bodies and unresisting minds of these *criminals of the future*, condemned beforehand—*foreordained* by their unhealthful, and hence immoral, surroundings to careers of pauperism and crime. For their future detention and safe-keeping, living mausoleums are built and officered and maintained at an expense in money but grudgingly supplied for properly constructed school-houses, and at a human sacrifice which I will not attempt to estimate. The preventive method of dealing with immorality, on the other hand, anticipates the development of the potential offender by effecting ameliorations in public and individual health and by methods of education which include moral training; thus removing many of the predisposing causes of immorality—the development of sound minds in sound bodies yielding the necessary product of well-balanced lives.

Men do not, as a rule, become moral by intuition (although the moral genius, like the musical prodigy, is not unknown), but by patient organization of the moral faculties. The phenomena of vice and crime take place, not from any aberration of the laws of Nature, but in exact accordance with them, since educational neglects and unsanitary conditions, with their resulting diseases, lead to imperfect mental development or to the perversion of normal mental qualities. The development of moral activities must be recognized as dependent on the same principles as that of other activities, and the human being must be trained in morals as he is trained in athletics, in music, and in the mechanic or other arts. "By dint of forging, one becomes a blacksmith," says the French proverb; while all the talk of all the black-

* "Book of Health," Malcolm Morris.

smiths the world has ever known would not effect the desired result. "In these bewildered times," said Carlyle, "all education has run to tongue." This is emphatically true of moral education; but the "line upon line and precept upon precept" plan of moral training has ever failed, and will ever fail, of the best results. The child must be exercised in moral conduct until a real knowledge of acting rightly is acquired. The Esquimau baby cries for blubber as the American child does for sugar, and splutters at the first taste of candy as do our own pale infants on their introduction to cod-liver oil—a fair illustration of a universal principle.

Whether, then, the facts with which we have to deal be physical or whether they be moral, they have their causes: vice and virtue are products resulting from complex combinations of the more simple phenomena on which they depend. We are, in short, the true offspring, not the mere step-children, of our mother, Nature; and as our bodies are built up of and maintained by gases, fluids, and solids temporarily withdrawn from the crust of the earth and its gaseous envelope, so our characters are being continuously molded, primarily by the universal natural forces, but more immediately by the social forces incident to life in communities. Conduct is contagious. The manifestations of sentiment, of passion, of impulse, etc., excite similar manifestations in others who have the capacity for like experiences; and to the *contagia viva* of the bacteriologist must be added a moral contagion the existence of which is proved by the occurrence of epidemics of crime, especially of crimes of the gravest character. A discussion of the methods by which moral contagion is disseminated can not be entered upon at this time. Suffice it to say that, in the city of Ethica, no newspaper will be permitted to act the part of a culture-fluid for the propagation of this contagion by the publication of criminal reports which familiarize the minds of their readers with the details of crime, if they do not actually create crime epidemics. Neither will the system of inoculation—by the "sowing of wild-oats," so called, or other similar methods—receive the slightest encouragement, since this plan is more likely to establish a favorable diathesis than to secure immunity from disease. The maintenance of a high physical tone is most important, since, in the suggestive language of Rousseau, "The weaker the body, the more it commands; the stronger it is, the better it obeys"—a seeming paradox but a true indication of that state of desirable self-control which consists in the ascendency of the intellectual and moral over the instinctive and emotional traits, and which more than anything else distinguishes the highest and best exponents of humanity from its least developed types.

Having, as I believe, demonstrated the dependence of moral development upon hygienic living as its physical groundwork, and the fundamental incompatibility between physical disease and moral health, it only remains to add that the observance of moral requirements is essential not only to physical well-being, but to the highest intellectual development and happiness ; that, in fact, the pursuit of health and the cultivation of morals are alike to be regarded only as means to higher ends. It is obvious that the man of fine *physique* does not live for the observance of the laws of hygiene merely, but he observes hygienic laws as a necessary means of comfortable and wise living. So neither does the upright man live merely for the observance of moral laws, but he observes moral laws not only as the mode of living which is alone endurable to him, but as essential to the full realization of his best possibilities and powers as an intellectual and spiritual being. Personal morality has, in fact, been defined as the highest degree of *psychical health.* From this point of view it appears that as hygienic laws are an expression of the most complete adjustment between the physical life and its physical environment, so the moral law is an expression of the most complete adjustment between the psychical life and the social environment.

The most difficult of ethical problems is regarded as that of uniting the highest well-being of the individual with the greatest good of society—the reconciliation of an advantageous egoism with that degree of altruism which the welfare of society demands ; but that there is ultimately no antagonism between these two objects is evident when we look deeply enough and broadly enough at the problem. The definition of morality just given brings out the fact that individual progress and the progress of society at large are inextricably associated —that we can not, if we would, separate ourselves from the great world of humanity of which we form a part.

Whoever, then, pursues a career which ministers to the welfare of society as well as to his own individual good, contributes doubly to the general progress. How conspicuously this applies to the medical life (and in a far higher sense than is generally understood) it has been my purpose to show this morning. May you pursue your chosen work with all the devotion of heart naturally inspired by scientific truth consecrated to the highest interests of humanity ! In contributing to these interests, your own personal aims can not fail of satisfactory fulfillment.

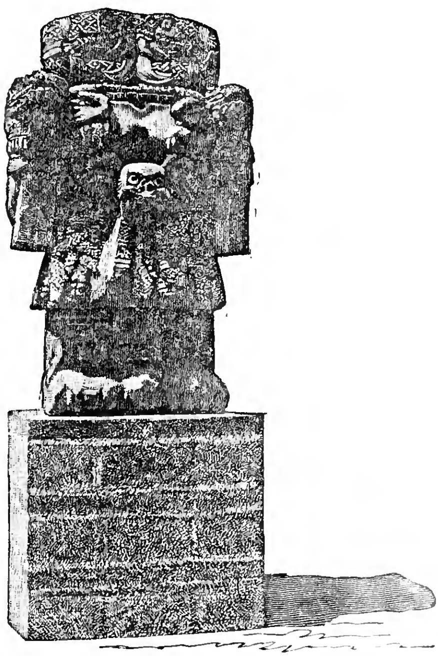
The first Roman emperor whose name marks a golden era in history is said to have claimed as his greatest triumph that, having found Rome a city of sunburned brick, he should leave it a city of marble. May your ambition as far exceed that of the great Roman as the future city of Ethica will outvalue that world-renowned city of the past ! May you contribute toward the glad appearing of this long-sought paradise—this city of our dreams—whose foundations shall be laid upon recognized natural laws ; whose streets shall be paved with good intentions realized ; whose walls shall sparkle with the gems and fine gold of virtuous and generous conduct ; and whose atmosphere shall nourish the highest intellectual pursuits, unhindered by physical ills and unhampered by ignorant prejudice; a city, in short, in which the bodies of the inhabitants shall have become living temples of truth!

There will be no night in that city, since Truth is itself the eternal source of light, and *her torch is never inverted.*

## MEXICAN ANTIQUITIES.

BY RANDOLPH I. GEARE.

IN the southeast range of the National Museum at Washington is a collection of casts of Mexican statues, historical stones, and other figures of American antiquities, an examination of which alone is well worthy of a visit to the Museum. This collection was installed for exhibition by its owner, Señor Eufémio Abadiano, and was brought to Washington from New Orleans, where it had been on view at the Exposition in 1885. These casts are reproductions of precious specimens in the possession of the National Museum of Mexico, and of monuments of immense value from various parts of that republic. Our attention was first called to the "Aztec Calendar Stone," which, according to Gama, is a calendar for that part of the year between the spring and autumnal equinox, showing the movements of the sun and the times at which should be celebrated the principal feasts of the nation. In the center are four rectangles which form a figure constituting the sign of *Nahüi Ollin*, and represents the four movements of the sun. The figures in the circle outside of these rectangles represent the twenty days into which the month was divided. The divisions of the day are shown by eight large angles. The stone served as a sun-dial, by means of which the times for ceremonies and sacrifices were ascertained daily. The original monument is believed to weigh twenty-one tons. Close by is the cast of the statue *Teoyoamiqui*, or Goddess of Death, about eight



TEOYOAMIQUI, OR GODDESS OF DEATH.

feet and a half in height. The original was found buried in the city of Mexico ninety-six years ago. Humboldt believes that this and other idols were placed under-ground by Cortes and his men in order to escape the observation of the Aztecs, to whom these idols would doubtless prove a serious obstacle to their embracing Christianity; but it seems more reasonable to suppose that these idols were buried by the Aztecs themselves, in order to prevent their capture by the soldiers. The goddess *Teoyoamiqui* was charged with the gathering in of the souls of persons killed in battle, it being supposed that their souls went to the mansion of the sun in heaven, where they were eventually transformed into humming-birds.* Near this is a cast of the statue of the goddess *Mictlanteuhtli*, who presided over *Mictlanteuhtli*, by which name the Mexicans denoted the place to which the souls of those who died natural deaths were transmitted.

Perhaps the most interesting cast in this collection is that of the Sacrificial Stone, which was found ninety-five years ago in the city of Mexico. The complex figures and hieroglyphics on this stone utterly astound the visitor to the Museum, and are only to be descried, to say nothing of being understood, after the most careful examination. This stone is about two feet eleven inches high and more than twenty-seven feet in circumference. On its face is sculptured the image of the sun, and around the stone are fifteen groups of two persons each, one of each couple being represented as victorious over the other. The number of victims indicates the number of conquered tribes. In two couples the victim is a woman, which probably denotes that those two tribes were governed by women. A groove running to the margin from the center marks the course for the flow of the victim's blood. The conqueror is Tizoc, sixth king of Mexico, who reigned from 1481 to 1486, and the monument is commemorative of his victories. A cast of the famous statue of Chac-Mool (tiger), about two feet six inches high, is in the collection. The statue is believed to be twelve thousand years old, and was, it is said, erected to the memory of Chac-Mool by his wife. In the valley of Mexico and in Tlascala statues of similar form have been found, and it is therefore assumed by some that the same divinity was worshiped both in Mexico and Yucatan. The statue was discovered by Dr. A. Le Plongeon in the ruins of Chichen-Itza, Yucatan, and removed by the Mexican Government to the National Museum of Mexico. Of exceeding interest is the reproduction of the Commemorative Stone in remembrance of laying the foundation of the great temple of the Aztecs, the building of which was commenced by *Tizoc*, who was desirous of erecting a sacred edifice which should be the wonder of all the nations on earth. It was not finished by him, its completion being reserved for *Ahuitzotl*, his successor, in the year 1487. This temple has now given place to a magnificent

* Charero, in his "Anales del Museo Nacional de Méjico," vol. ii, p. 293, holds that it represents the earth-god, *Coatlicue*.

cathedral. A cast of a cylinder known as "The Mexican Cycle" is very interesting. Among the Aztecs every fifth day was a day of rest, called *Tianquiztli*, and five of these periods constituted a month of twenty days, eighteen of which made up a year of three hundred and sixty days, to which were added five more to make up the proper length of the year. The cycle or century was composed of fifty-two

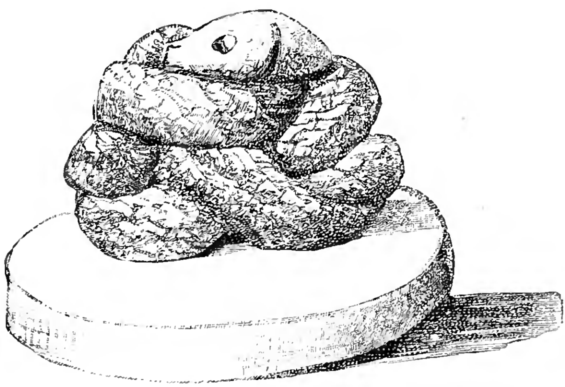
SACRIFICIAL STONE, OR CUAUHXICALLI OF TIZOC.

years. This cylinder is composed of a bundle of reeds tied with cords, representing a cycle, or *xuihmolpilli* in the Mexican idiom, the signification of the word being a "union of years." The Aztecs believed that at the close of the cycle the world would come to an end, and the last night of the cycle was a time of great anxiety for them. They destroyed their goods, threw away their valuables, and offered human sacrifices. As soon as the moment of suspense was passed, and it was seen that the world had not been destroyed, but would last another century, sadness and penitence gave way to the greatest hilarity, the beginning of the feast being signalized by the priests, who, with the aid of two dry sticks, ignited a fire which was carried far and wide in token of the continuance of the world's existence.

Placed near by is a cast of an immense head, which is supposed to have occupied a position in the great Aztec temple. Some archæologists believe that it represents the lost Atlantis, with her head-dress of water dotted with shells. In the Mexican town of Tenango was found a stone about five feet ten inches high, upon which are sculptured the four fatal epochs in Nature which the Aztecs assert had taken place. These epochs are *Atonatiuh*, or water-sun (corresponding to our deluge); *Ehecatonatiuh*, or wind-sun; *Tletonatiuh*, or fire-sun; and *Tlaltonatiuh*, or earth-sun. A cast of this stone is among the series. We also notice a cast of the "Cross of Palenque." The use of this symbol by the Mexicans of remote date is by some advanced as an argument to prove that, at that time, Christianity was established, or at least taught, in their country. Others, however, regard the symbol merely as an astronomical sign, indicative of the four seasons, four winds, etc. On this cross is represented a priest offering up a child to the sacred bird, which is perched on the top. At the bottom of the cross is a large face with open mouth and an ornament hanging from its nose. The "Palenque Divinity" is represented by the figure of a god on whose head is a diadem of plumes. On the forehead is typified "Eve's Serpent," in the form of a star, whose presence in the heavens is significant of harvest-time. This is the god that creates and is opposed to the destructive genius. The serpent referred to was *Sérapis* among the Egyptians, *Wischnou* with the Indians, *Vitzlipultzi* in Mexico, *Fohi* in China, *Esculapie* with the Greeks, and *Thor* among the Scandinavians. There is also a cast of a bas-relief supposed to have come from Palenque. On it is depicted a man being punished in some way, his hands tied behind him, and

COLOSSAL HEAD OF TENANGO.

extreme pain being evident both in his face and from his attitude. A cast of what is believed to be a statue of *Chalchiuhtlicue*, Goddess of Water, was also shown us. The statue came from a mountain near Tlalmenalco. This divinity was sister to the gods of water, *Tlaloques*. A yoke from Orizaba is in the collection. This is made of stone and is of a green color. At the top of the yoke is a head, like that of a snake, and the entire yoke is polished. These were used on the occasion of human sacrifices, and were placed over the heads of the victims whose hearts were to be taken out. Next in order is the cast of a statue of a woman who, by her costume, appears to have belonged to the Aztec nobility. Around her waist is a rattlesnake, and this fact leads to the supposition that the statue is that of the "snake-woman"—the goddess *Cihuacoatl*, from whom the Aztecs believe the entire human race has descended. There are also in the collection casts of two feathered serpents and other mythological animals; of a



FEATHERED SERPENT.

humpback, who is supposed to have been a son of King Tizoc, to whom reference has been made; of the water-goddess, etc. Conspicuous, too, are two funeral urns, beautifully carved inside, and with skulls upon the convex surface. A great vase or tub is in this series. From various water-animals sculptured on the base it is supposed to be commemorative of the deluge, but little is known of its meaning. A large grasshopper (*Chapolin*) stands near the "tub," and is supposed to be commemorative of the end of the wanderings of the Aztec tribe which terminated at Chapultepec (hill of the grasshopper).

Neither time nor space will allow a detailed description of some of the smaller casts in the collection. It is, however, safe to say that every piece has connected with it an interesting history.

# PRAIRIE-FLOWERS OF EARLY SPRING.

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BOTANY has so changed, broadened, and deepened, within the past twenty years, that it may seem like retrogression to talk of flowers. The average botanist of to-day has gone so far beyond mere blossoms, as such, in his study of minute anatomy or in his experiments upon vegetable physiology, that he sometimes almost forgets there are such things as sepals and petals. He must confine himself to a single cell, or at most a group of cells; a tissue, or possibly a tissue system, or else his associates will speak of him as being so broad that he must be shallow. The division of labor, in fact, has gone so far that one person studies pollen for a lifetime, while another counts that day lost in which he does not gain some new fact upon the endless subject of chlorophyl. There are hundreds of noted botanists who pay no attention to flowering plants except as they are the hosts of, and subject to destructive inroads from, the almost countless species of cryptogamic plants belonging to the rusts, smuts, blights, mildews, and molds.

It therefore requires much courage in this age of advanced botanical thought to attempt to write upon a theme that is so broad as the one selected. "Spring flowers" bears the marks of wear, especially in the hands of those who can do almost anything better than make rhymes. The practical eye of the penetrating student of plant-life has gone beyond the beauty in flowers, and finds a golden thread of adaptation which the average "spring poet" has never dreamed of, even in his highest flights after the soul of things. However, for the genuine poets be it said that it was reserved for the immortal Goethe to first comprehend the true morphology of seemingly so simple a structure as a flower.

The season of flowers opened unusually early this year—how much more so than the average can only be told after observations have been taken over a series of years. Ten years from now it is hoped that the record will be so complete that, with watch in hand, the hour may be given when a certain flower may be expected. There is doubtless a floral clock for the year as there is one for the twenty-four hours of a single day. Perhaps there has been a great Phyto-convention held somewhere, and a majority, if not all, of the choice bloomers were in attendance. Each was assigned its place in the calendar, and if the petals do not unfold and fade away with the regularity of the unerring time-piece, it is no fault of the plant. Upon the surrounding circumstances, and not upon the plant, must rest any blame for irregularity. To any one who has made a careful inspection of the thoroughness with which the pussy-willow prepares for the coming spring, even before the first chill of autumn thrills the summer air, it will be unnecessary to dwell upon this fact. Even in these October days, when the leaves are chasing each other down the roadway, driven by the cruel wind, there are bright promises of another spring-time left behind upon the shrubs and trees. The foliage may fall, but its work remains. Their long summer days of toil are not for naught. Within the closely knit covering of the bud sit the germ of a future branch with its leaves defined and its flowers planned. Those who see only evidences of death and decay in the leaf-stripped tree are surface-sighted. A plant is never more itself than when it is fully prepared for a period of repose. It is now most independent and most highly charged with what the physicist would call the energy of position. The plants, therefore, that bloom early in the spring are not idlers through the balance of the year; they ripen their seed, or, in other words, rear up a fine family of children. Each offspring, provided with an outfit for the early struggles of life in the shape of starch, and oil, and protoplasm, is invited to shift for itself. More than this, the mother-plant, if it is the plan that she shall live on, spreads new leaves to the sunshine, and the work of food-making goes on during every day until a store of nourishment is packed away for use in the early growth of the plant the following spring. As a rule, spring flowers are made out of last year's material, and, in this sense, are not as fresh and new as those that come later in the season.

Over fifty pairs of anxious eyes were watching last spring for the first flowers of the year, and it is safe to say that not many days elapsed between the appearance of the first blooms of a species and the time they were discovered. It was none other than the hepatica, or liver-leaf, that first opened its delicate blossoms to the chill air. This was on April 6th, and many days before the snow-banks had silently stolen away. The fact that this little forerunner of warmer and better days has been recently uprooted by botanists and transplanted in another genus seems only to quicken its pulse and make it breathe the air of April more freely. *Hepatica acutiloba* (DC.), of my earlier botanical days, has changed to *Anemone acutiloba* (Lawson). It by any other binomial botanical title would bloom as early and smell as sweet. Its twin sister has undergone a more violent treatment, and, instead of *Hepatica tribola* (Chaix), it is settled among the wind-flowers as *Anemone hepatica*, where the immortal Linnæus had placed it a century ago. The fineness and even brittleness of the thread by which a species is hung is well illustrated by these two hepaticas. Without considering how minute were the characteristics upon which the genus *Hepatica* was founded by Dillenius, let us see in what the two American species differ. Dr. Gray, in his "School and Fleld-Book," says: "*Hepatica triloba* (round-lobed hepatica), leaves, with three broad and rounded lobes, appearing later than the flowers and lasting over winter; stalks hairy; flowers blue, purple, or almost white; woods, common East. *H. acutiloba* (sharp-lobed hepatica), wild from Vermont, West, has pointed lobes to the leaves, sometimes five of them, and paler flowers."

We are not favored with the round-lobed hepatica in this vicinity, and can not say from observation how bright its flowers might be in the pure, clear atmosphere of this prairie-region; but it is true that the sharp-lobed species does not *pale* in comparison with the Eastern flowers of the *A. hepatica*, unless my memory has faded in the mean time. The blue we get is deeper than can be caught from the sky on our clearest April day. There remains little else upon which to hang the species except the shape of the lobes of the leaves, and this is exceedingly variable. Last spring a patch of a hundred blooms or more grew close by the retreating edge of a snow-bank, only a few feet from my window, and the little clusters of blossoms varied so much among each other that an unobserving person would look the second time to note the shades of color. The foliage in like manner varied, and in some instances it seemed that there was evidence enough in that one bed to overthrow the strongest belief in there being two species of American hepaticas. I say we do not have more than one species here, and that is largely due to the fact that it is easier for us to put them all under *A. acutiloba* than to try and distinguish the two. To say that the acute-lobed leaves are sometimes five-lobed, is no distinction. In the college herbarium is a specimen of the roundest of the round-lobed from Michigan, with this same characteristic. The greater number of sepals (seven to twelve) in the *A. acutiloba*, there being six to nine in the other, has little weight, especially if we examine the specimens of *A. hepatica* from Europe. In turning to "The Manual," it is found that Dr. Gray, of course, comprehends the situation, and adds the following "saving clause" at the close of the description of *H. acutiloba*: "Perhaps runs into the other."

One further observation upon the hepatica, and then we will hasten on to other and quickly following April flowers. One plant of the *A. acutiloba* was found, the calyx of which was unusually small and dark blue, while the involucre was larger than ordinary. A closer examination revealed that these flowers were pistillate, and only vestiges of stamens could be found, and these in only two of the many flowers. The pistils, thirty-five to fifty in each flower, were about double the average number in ordinary blossoms. The plant seemed to be quite generally "off the track." The involucre of one flower had a fourth leaf (the ordinary number being three), which resembled a sepal in form and bright color. One of the three green leaves of the same involucre, instead of being of the normal entire form, was trilobed at the tip, giving it a strong resemblance to a leaflet of the meadow-rues (*Thalictrum*), an adjoining genus. Upon looking up this interesting unisexual tendency in the hepatica, it was found that Dr. S. Calloni had recently made a similar observation in Europe on *Anemone hepatica*, as indicated in the "Journal of the Royal Microscopical Society" for April of the present year.

The next in order of time of our early-blooming plants comes the wild hazel (*Corylus Americana*, Walt.). This shrub would be passed by by the seeker of showy blossoms. Like most of the species of its order (*Cupuliferæ*), including the oak, chestnut, beech, and hornbeams, the staminate or male flowers are in drooping, cylindrical clusters, without any showy calyx or corolla. The pistillate or female flowers are elsewhere upon the same shrub, and are likewise inconspicuous. We have, therefore, in our first two flowering species, many widely different characteristics. The hepatica is a small herb that clings close to the earth, and may flourish under the protection that the hazel-bush yields it. The liver-leaf has showy flowers, which it holds up on long stalks in a conspicuous manner, and bears in each blossom both the essential organs (stamens and pistils) for the production of seed. The hazel has its sexes separated on the same shrub, and attempts no display of attractive color or forms. These two species, that bloom on almost the same early April day, have so little in common that they can not be rivals in any sense. They are moving along on independent lines, which for each, under its particular circumstances, are lines of least resistance. It may be that in this thought we find a solution of the problem of their very early blooming.

On April 11th two widely different plants were found in flower, namely, the first of the sedges (*Carex Pennsylvanica*, L.), and the blood-root (*Sanguinaria Canadensis*, L.). The little early sedge may claim some kinship with the hazel in this, that the flowers are of two kinds, and the staminate or pollen-bearing are more conspicuous than the inobtrusive pistillate or seed-bearing blossoms. Both the hazel and sedge depend upon the capricious winds for the transport of their pollen from the male to the female flowers. Darwin claimed that "Nature abhors continual close fertilization"; that is, the fertilization of the ovules of a flower by the pollen of the same blossom. In the hazel and the sedge we find the strongest sort of proof of such a doctrine. Close fertilization is impossible, from the simple fact that each flower is unisexual. The blood-root presents us with another side of the great and interesting subject of adaptations for cross-fertilization which was developed by Conrad Sprengel nearly a century ago, and given its present form by Darwin in 1862. What lover of flowers does not know the blood-root in its home among the decaying leaves along hedge-rows and out in the rich, open woods? Who does not recall the strangely and neatly lobed palmate leaf, up through the coil of which the plump bud pushes its way, and in a day has blossomed and gone? It may be some young botanists have been puzzled over the "sepals 2" of the manuals, forgetting that this wide-awake plant, having no further need for the firm, protective covering to the flower-buds, drops its two sepals as they open, leaving the delicate, pure, white petals and the April insects to succeed as best they can in the work of cross-fertilization. Just what kinds of bees, or bugs, or beetles stand ready to rob each opening flower of its sticky pollen, I am not prepared to say. It is true that the blood-root has few competitors, at this time of year, for the employment of the insect tribes. Its petals are large, and doubtless catch the watchful eyes of the hungry insects at long range. The plant and the insect work together, each selfishly, yet each successfully. The mutual adaptation existing between some flowers, as those of many orchids and their attendant insects, is so complete that neither the plants nor the insects could well exist without one another. Some plants are absolutely dependent upon certain insects for the transfer of their pollen, while these same insects could not subsist without the flowers from which to extract their daily food. In our little blood-root, we do not believe such a thorough dependence exists. If insects do not bring more potent pollen from some other flower, that of its own, falling upon the stigma close by, will suffice.

On April 13th two species were found in flower, and between them there are seemingly wider differences of structure than were pointed out in the last two. The white elm (*Ulmus Americana*, L.) is a large tree, famous for its grace and beauty in the hands of the landscape-gardener. The *Stellaria media* (Smith) is the common chickweed, so abundant around dwellings in every part of the world. The stately elm is an American species, as its botanical name indicates, while the chickweed is one of a large class of plants which have come to us unbidden, and frequently unwelcomed, from beyond the sea. Its greatest economic value seems to be as a salad-plant for canary and other imprisoned birds. This little, insignificant herb delights in cold, shady soil, and frequently opens its blossoms beneath, or when surrounded by, drifts of snow. There seems to be no good foundation for this haste, as the plant continues in bloom during nearly its whole lifetime of a year or more. It also seems as if it would be just as well to delay flowering until insects are more numerous, at which times the blossoms secrete so much honey that the drops may be seen without a hand-lens. Among other insects, the prolific aphides (plant-lice) and the ubiquitous house-fly (*Musca domestica*, L.) are attendant upon the unobtrusive chickweed-flowers. The blossoms of the elm are also small, but depend upon the winds for transfer of their pollen. The leaves do not unfold until the flowers are past, and in this circumstance we may see an instance of the working of the law of adaptation. The foliage might interfere with the easy movement of the dry, dusty pollen from one tree or branch to another. Students of plant-life are always pleased to observe that adaptations for cross-fertilization are worked out along very many lines. The elm offers an instance in which there is a seeming confusion in the floral type. Botanists say the elms are polygamous, which only means that some flowers are perfect or hermaphroditic, having both stamens and pistil, while others are unisexual, being either staminate or pistillate. This appears to indicate that the elm is passing through a transition state, either toward a final separation of the sexes, as in the hazel, or is approaching those plants which have their flowers all perfect, as the magnolias or tulip-trees.

The *Ranunculus repens* (L.) opened its bright-yellow petals on April 14th, and was the only new flower for that date. This creeping buttercup is one of a large genus which takes its name from the Latin word for a little frog, applied to these plants by Pliny, because many species are aquatic and abound with the frogs. The English farmers rank this early spring plant among their weeds, and like many other plant-pests it has a remarkable provision for spreading and occupying the land. Shortly after the flowers have faded the plants send out runners which quickly take root at their joints as in the strawberry, and before midsummer has passed the mother-plant may have a brood of young extending far beyond the protection of her "wings" or leaves.

April 15th has four species recorded against it on the note-book, namely: *Isopyrum biternatum* (T. and G.), *Dicentra cucullaria* (DC.), *Capsella Bursa-pastoris* (Moench), and *Erythronium albidum* (Nutt). What a variety is here presented in so small a number! There are as many orders represented as species. One is an endogen of the lily family, and should be called spring-lily, instead of white dog's-tooth violet. There is very little to suggest a violet in shape or color, and, as for the "dog's-tooth" part, the quicker it is extracted the better! The other three species are disposed among the exogens; the isopyrum, or enemion, falling in close by the side of the crowfoots and the marsh-mangolds, but a thousand times more delicate in habit than the latter. It is the ordinary wind-flower exalted in its foliage to the attractiveness of a maiden-hair fern. The student, during his first spring among the early flowers, is quite liable to confuse this isopyrum with the rue-anemone (*Thalictrum anemonoides*, Michx.). At this he should not grieve because older heads have been troubled with this little thalictrum—which now is no more a thalictrum. Of it De Candolle wrote, "Habit and frondescence of isopyrum with the inflorescence of anemone and the fruit of thalictrum." Spach has placed the little puzzler in a new genus and calls it a little anemone that is much like a thalictrum, viz., *Anemonella thalictroides*. This is only one of many instances where further study of a species has led to a new setting in the system; in fact, a large part of the work of the systematic botanist in the future will be the erasing of old, confusing, ill-defined lines, and the drawing of clearer and stronger ones. But, wherever the rue-anemone may go in the classification, its likeness to the isopyrum will remain, and, coming as these two plants do at the same time in April, they will always furnish a test for the discriminating powers of the student. To these two species add the wind-flower (*Anemone nemorosa*, L.), all of which appear at about the same time and in similar situations, and the student has three forms over which he may work for some hours before the representations of the three genera are satisfactorily determined. It is, however, just such work that opens the eyes of the young naturalist and makes him mindful of little things. The shepherd's-purse (*Capsella Bursa-pastoris*, Moench) is an intruder from Europe that has found its way into our cultivated ground, and become most ugly because so much in the way of other and better plants. This weed seems to be running a race to the seed-goal with some other of our plant-pests. During the present season strings were tied upon certain flower-stalks when their flowers were in bloom, and a record was kept of the time required for the maturing of the seed. The number of days varied from fourteen to seventeen. This is in striking contrast with the two long years of maturation required for the acorns of many species of oaks. The ubiquitous dandelion can, however, win the pennant for quick-seeding from the shepherd's-purse. It can reach the home-line when capsulla is only half-way round the track. But while a dandelion-plant, on an average, produces 1,720 seeds, the shepherd's-purse ripens 17,600, or more than ten to one! The same student has determined this year that these figures are low indeed when compared with those for the offspring of the purslane speedwell (*Veronica peregrina*, L.). This small plant began flowering on May 3d, and before six weeks were past it had produced 186,292 seeds. What some plants may lack in size and durability they make more than whole by wonderful powers of reproduction. The *Dicentra cucullaria* (DC.) is the interesting "Dutchman's breeches," with the heart-shaped corolla, much like its cultivated favorite sister, the *Dicentra spectabilis* (DC.), better known as "bleeding-heart," with its long, gracefully bending stems, each bearing a dozen or more of rosy "hearts." Our early wild dicentra exceeds its cultured relative in delicacy and beauty of foliage and its strange-shaped flowers, which are, although smaller and less highly colored, not less interesting structurally. The visiting insect, intent upon securing the honey secreted at the base of the petals, must brush aside a close-fitting cap or hood before the pollen and the stigma may be touched. The two canals leading to the nectar are so constructed that the insect, usually a bee, in thrusting his proboscis into either, brings his body against the hood and, pushing it aside, dusts fresh pollen from some other flower upon the stigma. Before he leaves, new pollen is unintentionally secured by the insect for the fertilization of the next flower visited. The hood of the pendent blossom falls back to its accustomed place as soon as the bee retires, and again incloses the pistil and the six stamens situated close around it. When we remember that the stamens of a particular flower may mature before its stigma, it is easy to understand that the pollen of that flower, although placed close by the side of the stigma, is designed for some other flower, and the presence of nectar and proboscis-canals, as well as a fine landing-place for the bee, at the base of the hanging corolla, are all to secure cross-fertilization. This little species has worked out the problem in a most interesting way, and doubtless the insects have had much to do with determining these final results.

The box-elder and the silver-maple began blooming on April 16th. There is no evident relation between size of plant and extent of floral structure. Some Alpine gentians have flowers an inch long, while the balance of the plant is shorter and probably has less weight than the single blossom it bears. The most wonderful flower of all is that of *Rafflesia Arnoldi*, which sometimes measures nine feet in circumference and weighs fifteen pounds. These monstrous blossoms are almost without stem, being sessile (sitting) upon the branch of the vine from which as a parasite the flower derives its nourishment. In striking contrast with this obese robber the stately and independent silver-maple has inconspicuous flowers that might be readily overlooked if they did not appear before the foliage. The genus *Acer*, to which the silver or soft maple belongs, is very variable in this last point. Some species, like the one in hand (*Acer dasycarpum*, Eh.), flower before unfolding the leaves ; others, like the highly prized sugar-maple, have the flowers and leaves appear at the same time ; while others are laggards, and bring forth their blossoms after the leaves are fully formed and busy with their work. The same differences hold as to the time of ripening the seeds. The silver-maple has its seeds ready for the last breezes of May, and upon the large wing each little plantlet takes an airing that the thoughtful student watches with much delight. If the breeze is strong, the seed passes along with the unsteady and rapid progress of a butterfly, usually with a downward course from the tree-top, where it was borne, but sometimes it rises and hastens on, perhaps to fall on rich soil a hundred rods from the parent tree. Each of these winged fruits bears a single seed within, and as the fruit falls upon the ground the heavy end strikes first, thus bringing the root of the little plantlet in the best position for rapid development. When the fruits fall upon sod-ground, the condition that often obtains in Nature, the passing breezes play upon the uplifted wing and tend to work the heavy seed end of the fruit into the turf. Under favorable conditions the soft-maple seeds germinate at once, and, before the season closes, seedlings a foot or two in height may be produced. The late-flowering maples do not make any such progress, and seem satisfied if they simply secure a good crop of seeds. In order to test the importance of the soft-maple seeds obtaining a suitable place for germination as soon as they are mature, a quantity were gathered and stored in a dry place, where other seeds are kept. A year after they were sown in rich, moist soil, alongside of a row freshly gathered from under the same trees. None of the year-old seeds grew, while the fresh ones soon sent up their stems and leaves. The silver-maple plantlet is pulpy and already of a deep green when it falls from the tree, and probably is killed as soon as it becomes thoroughly dried. The seed runs many risks for the sake of being a sizable seedling the same season.

The box-elder (*Negundo aceroides*, Moench) belongs to a most closely related genus to the maples, and by some botanists it is placed with them in the genus *Acer*. The most striking difference is seen in the leaves, those of the box-elder being compound like the ash, hence one of the common names, "ash-leaved maple," while the leaves of the familiar maples are simple. In the box-elder the sexes are separated much more clearly than in the maples. One tree bears only staminate flowers while another has only pistillate blossoms, and therefore bears the fruit. To have good seeds it is necessary that at least two box-elder trees be in the same vicinity, and one of these must be male and the other female. This tree is the type of hardiness in the severe climate of the Northwest, but in this connection there are some points not easy of explanation. The box-elder of one section of the country may be identical in structure with specimens in a different climate, but widely different in hardiness. This brings to view again the law of adaptation as applied to the inherent ability to withstand the untoward circumstances that have surrounded the ancestry for long periods in the past. The same is true of many other species growing over wide areas of country. They may possibly retain the same botanical characteristics, but beyond all that the eye, with the aid of the best microscopes, can see, there is that which enables one plant to flourish when another will fail.

The 17th of April brought blossoms of *Caltha palustris* (L.), and *Carex stricta* (Lam.). The first is the marsh-marigold, or perhaps more familiarly known as the "cowslip." The genuine cowslip of the poets is a different plant, it being a primrose. The caltha is a pot-herb of no great merit, and does not possess that type of beauty which inspires the muse. The carex is the second sedge of the season. It doubtless has its place to fill in the scheme of creation.

April 18th introduced us to three species, the *Populus monilifera* (Ait.), or cottonwood; *Antenaria plantaginifolia* (Hook), the plantain-leaved everlasting; and *Viola palmata*, var. *cucullata* (Gray), the common blue violet. Spring has now fairly opened, for the violets have come. This day throws together in the list three very different plants. The poplar is one of the most wide-spread and hardiest of trees. It is the only kind of arboreal vegetation in many places along water-courses of the Northwest, in regions subject to severe climatic conditions. It can bear the heat and drought of summer and the extreme cold of winter when other forms succumb. It may be worthy of note that this hardy tree produces timber that is among the lightest on the list of woods in the United States. Its specific gravity is only .3886, or a little more than one third as heavy as water. We have sixteen species of trees yielding wood heavier than water. Nearly all of these are in the Southern States, and several are confined to the extreme south of Florida, which is a tropical or sub-tropical region. The Southern pine (*Pinus palustris*, L.), from which we get an excellent lumber, besides pitch, tar, turpentine, etc., is nearly twice as heavy as the Northern or white pine (*Pinus strobus*, L.). The very hardy box-elder yields only a light wood. It would seem that firmness of texture and great specific gravity of wood are not characteristics that accompany ability to induce wide ranges of conditions and sudden changes in temperature.

The little everlasting, with leaves like the plantain, although covered with a soft, silky wool, is the earliest representative of the largest of all the natural orders of flowering plants, the *Compositæ* or sunflower family. It does not announce its coming into bloom by any display of showy colors, and the young naturalist could be forgiven for either not seeing it, or not desiring to struggle with it, through the bewildering maze of the key to the genera of this difficult order.

The *Viola cucullata* of Aiton has gone, and in its place we must write *V. palmata*, var. *cucullata*. Dr. Gray, in his recent revision of the North American violets, of which he finds thirty-three species, has restored *Viola palmata* of Linnæus. This is a very variable species. There seems to be no part of leaf or flower that is not subject to a wide range of variation, unless we except the three-valved pod with its single cavity. Many species of violets are remarkable for a second kind of flowers, which are inconspicuous, closed, and self-fertile. They may be found in all stages of development beneath the soil and throughout the growing season. Last autumn the writer gathered a quantity of the seed from the underground pods and mixed them with seeds from pods produced by the ordinary flowers, and no one of the many persons to whom the mixture was submitted could detect any difference. Yesterday (October 14th) a class of one hundred students in elementary botany analyzed the *Viola palmata*, L. Abundant material for this exercise was obtained on a piece of land near a railroad that had been burned over during the prolonged drought which lasted for more than two months in midsummer. The plants having passed through so severe a season, which was followed by abundant warm rains, perhaps have been deceived, and are arrayed in the garb they had prepared for spring. The form with entire leaves—the old *V. cucullata*—tinge the bank of the railroad-track with their unusually high-colored flowers, while the *palmata* is abundant on the higher land. The *V. delphinifolia* (Nutt.) is our most common violet of spring, but it has not been found in bloom this autumn, nor has any other than the ones mentioned been reported, although we have eight or more species and some varieties in the State.

The 20th of the month of showers, of smiles and tears, as the poet would say or has said, brought out the *Amelanchier Canadensis*

(T. and G.), and five other species. The amelanchier is often called "shad-bush" in the Eastern States, when the famous river-fish of spring have their period for ascending the streams, which time corresponds somewhat with the blossoming of the amelanchier. "June-berry" and "service-berry" are other names for this small tree, which, when in full bloom, is very attractive. The wild strawberry (*Fragaria Virginiana*, Ehrh.), a member of the same family (*Rosaceæ*) with the "June-berry," is recorded for the same day. The best of all strawberries, even in this age of a thousand cultivated varieties, were those gathered in youth upon the grassy hill-side. The flavor of the wild strawberry is nearly lost in many of the larger and more showy fruits of her highly pampered offspring. The toothwort, or dentaria (*Dentaria laciniata*, Muhl), and *Draba Caroliniana* (Walt.), or "whitlow-grass," come almost side by side in the manual as members of the *Cruciferæ* or mustard family. In the first we have an old friend of childhood days. Many an eager youth has burrowed his fingers deeply into the rich leaf-mold and earth, in search of the little potato-like root-stocks filled with a peppery and toothsome substance. The mustard-like flavor gets too strong as the root-stocks grow old, so that the luxury of gathering them in early spring is appreciated. Unlike its nearly related toothwort, the draba is a lover of sandy, waste places, where it, in its smallness and feeble growth, can have its own way. It does not enter into the sharp competition with other plants for the possession of the rich soil. Its strength and durability reside in its being content with poor fare.

The last but far from the least of the five flowering plants for April 20th was nothing less than the smooth lungwort (*Mertensia Virginica*, DC.). The bell-shaped flowers are of the choicest blue, a color that is both rare and beautiful in plants. It is no wonder that it has been transported from the moist banks of streams to adorn the flower-border in early spring, under the name of "blue-bells" or "Virginia cowslip," or, better still, "Mertensia," the generic name, taken from a German botanist, Mertens. The West has several of the mertensias, the most striking of which, to travelers in the Rocky Mountains and Sierra Nevadas, is the *Mertensia Siberica* (Don.). It covers the borders of mountain-streams with a rank herbage three to five feet in height, bearing a profusion of bright, light-blue flowers. This giant of the dashing mountain-streams has its dwarf form (var. *Drummondii*, Gray) upon the far-away Arctic sea-shore.

April 21st finds the prickly-ash (*Zanthoxylum Americanum*, Mill), the small flowered buttercup (*Ranunculus abortivus*, L.), and the round-leaved gooseberry (*Ribes rotundifolia*, Michx.), in bloom. The prickly-ash, sometimes called "toothache-tree," is perhaps the nearest of kin of the orange, lemon, lime, and shaddock that grows in this flora. The aromatic bark and pungent leaves are a poor reflection of the very agreeable aroma that accompanies the fruit of the tropical relatives. This disagreeable shrub, to make itself doubly sure of escaping the ravages of foraging animals, has armed itself with multitudes of keen prickles upon all its parts. It has won in the race, for in many places on the low land along the streams it occupies the ground to the exclusion of all else of a woody nature. The small-flowered buttercup is an instance of where, in a large genus having mostly showy flowers, the petals of a species may be much reduced. The wild gooseberry is a plant with possibilities that still remain undeveloped. It may have vast resources that only the practical horticulturist can develop in his own time and way. The gooseberry is not the only wild fruit plant that deserves the quickening hand of skill to bring it, in an improved and acceptable form, before the world. Our wild apples, plums, cherries, blackberries, thorn-apples, papaws, huckleberries, cranberries, and an extended list of native fruits, are all hopeful subjects for the fruit-grower. Let any who would begin the work of subjugation look at the results already obtained from the culture of the American grapes.

The 22d of the month has *Astragalus caryocarpus* (Ker.) and *Celtis occidentalis* (L.) scored against it. The former is a vetch, with a pod so hard and plump that it has taken the common name of "ground-plum." The latter, the hackberry, is a choice tree closely related to the elms, but bearing berry-like fruits instead of those with wings.

From this time forward the list for each day lengthens. For the 23d, the dandelion (*Taraxacum officinale*, Weber) ; the two wood-sorrels (*Oxalis violacea*, L., and *O. corniculata*, var. *stricta*, Sav.) ; false Solomon's-seal (*Smilacina stellata*, Desp.) ; wild ginger (*Asarum Canadensis*, L.) ; slippery-elm (*Ulmus fulva*, Michaux) ; and the wild sweet-william (*Phlox divaricata*, L.), make up a full list that ought to satisfy any ambitious collector. If we except the slippery-elm and the dandelion—the latter, because it grows as a weed in our lawn and not from any lack of inherent beauty—we have five species of spring flowers, strictly so called, and objects of the flower-hunter's search. The tyro will be quite sure to find the "prairie phlox" with its high and showy flower-cluster, and likewise he should return with the first of the smilacinas and the sorrels, but no blame will rest upon his head if he oversteps the inconspicuous although large flowers of the wild ginger that shyly keep close upon the ground beneath the plant's large reniform leaves. The next day added the following to the list of plants in flower: Gill or ground-ivy (*Nepeta glichoma*, Benth.) ; the great bellwort (*Uvularia grandiflora*, Smith) ; the little *Anemonella thalictroides* (Spach.), before mentioned with isopyrum ; and *Ostrya Virginica* (Willd.), the hop-hornbeam. The bellwort has the most showy flower of the day, and the hornbeam the least conspicuous. April 25th continues the list as follows: The star-grass (*Hypoxis erecta*, L.), the old hand-leaf violet (*V. cuculata*, var. *palmata*, Gray), its close of kin the larkspur-violet (*V. delphinifolia*, Nutt.), and the Indian turnip (*Arasæma triphyllum*, Low.), sometimes better known as "Jack-in-the-pulpit." The writer will never forget his first introduction to the tuberous root-stock, or "turnip," of the last-named plant. The mean face of the full-grown man who prepared a slice of the "turnip" for me (then only an inexperienced child) has never faded from my memory. My directions were to chew it and swallow all quickly. Only those who have tasted of the corm know how intensely acrid its substance can be.

For the balance of the month, and in the order here given, the following plants came into bloom: The bur-oak (*Quercus macrocarpa*, Michx.); wild plum (*Prunus Americana*, Marsh); white-oak (*Quercus alba*, L.); butternut (*Juglans cinerea*, L.); spike-rush (*Eliocharis obtusa*, Sch.); columbine (*Aquilegia Canadensis*, L.); hard maple (*Acer saccharinum*, var. *nigrum*, Gr.); meadow-rue (*Thalictrum dioicum*, L.); blue cohosh (*Caulophyllum thalictroides*, Michx.); wild black currant (*Ribes floridum*, L.); wild gooseberry (*Ribes cynosbati*, L.); and the lousewort (*Pedicularis Canadensis*, L.). This dozen species includes five trees, four of which are of great economic value, the hard maple and the white-oak taking the first places. Among the herbs, the columbine, or the "honeysuckle" of childhood, is the most showy. Boys as well as bees know that sweet is found at the base of each long spur-petal.

It will be seen that fifty-six species bloomed here (Ames, Iowa) during the month of April, or an average of about two and a half per day from April 6th, when the first blossoms of the hepatica were discovered, until the close of the month. The species recorded for May number seventy-seven and for June one hundred and thirty-one. The average for May is the same as for April, but for June it rises to four and one third per day. In July, it is five and a quarter new plants per day, Sundays not excluded. The season of 1886 has been an exceptional one. The spring opened early as the large number of species blooming in April substantially proves. During two months in midsummer there was only a quarter of an inch of rain instead of nine, which is the average. This drought pushed many species forward out of their natural places, and has doubtless much influenced the record.

The flora of the State of Iowa is not very large in numbers. Professor Arthur's catalogue made in 1876 gives nine hundred and seventy-nine species, including well marked varieties. Since 1876 one hundred and ninety-seven additions have been made to the list of flowering plants, thus increasing the total number to eleven hundred and seventy-six. A preliminary list for this county (Story), in which six hundred and nine species, and varieties are recorded, has been made the present season by a graduate student, Mr. A. L. Hitchcock, and to whom the writer is indebted for a full and careful record of the time of blooming of the plants in this vicinity. He was aided by a large class in botany, among the members of which existed a stimulating spirit of rivalry in bringing the first blooms of any species to the class-room. Over fifty observers, therefore, have been gatherers of the facts upon which the present paper is founded.

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# HATS AS A CAUSE OF BALDNESS.

By W. C. GOUINLOCK.

THE suggestive article in your October number, under the heading "A Bald and Toothless Future," should arouse more than a temporary interest. Of late, frequent reference to baldness has been made in medical and other journals, but none of the articles I have read have given the cause, it seems to me, nor suggested the proper means of prevention. The reasons given are mainly: Wearing a close, warm head-covering, thus rendering the natural one superfluous; the custom of cutting the hair close, living and working indoors, ill-ventilated hats, uncleanliness, and heredity. So many explanations indicate an uncertainty as to the real origin. Is it probable that such a uniform result can be due to so many and diverse causes, some of which must operate in one case and not at all in another?

The habit of wearing warm coverings on the head is not of recent date; the armies of Europe, for instance, no inconsiderable number of men, with heads close cropped, have worn for a long period warmer and heavier head-gear than the modern dwellers in cities, without the same tendency to baldness. Nor are the heavy fur coverings of northern races incompatible with luxuriant hair. It is also difficult to understand what injury can result from close cutting, *per se*. The growth is in the hair-follicle, and in it alone; there is no vital connection between the hair outside the scalp and within; it is usually cut closest at the back of the head and neck, where baldness never occurs. Would not close cutting rather stimulate the growth by exposure of the scalp? Such at least is the popular belief. So, too, with indoor life: women, who ought to show it most, whether in the home or in the factory, are never bald as men are; on the contrary, it is most common with men in good circumstances, as Mr. Eaton's statistics show, men who spend a larger proportion of their daytime in the open air than the indoor worker.

I believe the common form of baldness is due entirely to the kind of hat that is worn, principally to the high hat and the hard felt hat, but also to any other head-covering *that constricts the blood-vessels which nourish the hair-bulbs.* To have a clearer understanding of this, we must remember that the scalp is supplied with blood by arteries at the back, sides, and front of, and lying close to, the skull, which diminish in size by frequent branching as they converge toward the top of the head. They are in a most favorable position to be compressed, lying on unyielding bone and covered by thin tissue. Consider what effect must be produced by a close-fitting, heavy, and rigid hat: its pressure must lessen to a certain extent the flow of arterial blood, and obstruct to a greater extent the return of the venous; the result being a sluggish circulation in the capillaries around the hair follicles and bulbs, a consequent impairment of nutrition, and final atrophy. This pressure is not trivial or imaginary, as any one will admit who has noticed the red band of congestion on the forehead when a hard hat is removed after moderate exercise. If the man is bald, the red pressure-mark can be seen all around the head.

It may be asked, Can the wearing of a tight band around the head for a few hours a day have any perceptible effect on the growth of the hair? That the hair-bulbs are susceptible to disturbances of nutrition is evident from the effect of a continued fever, or any wasting disease, where nutrition is seriously impaired. They (the hair-bulbs) suffer with the general system; the hair has been starved to death, so to speak, and comes out in large quantities, sometimes amounting to temporary alopecia. If the hair-crop can be thus destroyed by three or four weeks of constant lessened nutrition, it is reasonable to suppose that the same cause, though slight and intermittent, will in time produce the same result.

The course of an ordinary case of baldness corresponds with this view. We observe usually a thinning out of the hair at the poll of the head, or part corresponding to the posterior fontanelle of infancy; a patch appears two or three inches in diameter like the tonsure of a priest. Or, instead, the thinness may begin above the forehead, but in every case, the hair disappears first where the circulation is weakest—that is, along the top of the head, the region most remote from arterial force. The sparseness, at first slight, becomes year by year more apparent, and, finally, a bare and polished surface is presented which gradually descends to the hat-band and there stops. Mark this point, it never goes below the rim of the hat. I admit that the line of denudation does not in some cases correspond exactly with the hat-band; it will be noticed that the coincidence is accurate enough at the back of the head from a point opposite the top of the ear on one side to the corresponding point on the other, but in front of this on either side is often a tuft above the horizontal line that still maintains its growth. The explanation is, that the temporal muscle, occupying the hollow space in the temporal bone, acts as a cushion, thus relieving the pressure on the blood-vessels. In men with rounded heads, full in this region, a continuous line will be observed.

Before leaving this part of the subject I would direct attention to the complete change effected in the scalp after the disappearance of the hair. Unlike the thick, stiff, glandular structure it formerly was, it is now soft, thin, and flexible, like that of the forehead or other portions of smooth integument. It has lost a distinct anatomical structure; the hair-bulbs and accessories have withered away. Baldness from disease has no choice of location; it occurs irregularly on any part of the head, or affects the whole surface, quite distinct in this respect from the perfectly regular course of hat-baldness. The latter should not be regarded as a disease at all, but rather as an accident of habit.

It does not follow that all persons wearing these objectionable hats must lose their hair. The outline of the head may be irregular, or the blood-vessels may be protected by a thick growth of hair. Close cutting, from this point of view, is injurious, as it allows close contact with the skin. But, few will escape the evil effects of twenty or thirty years of rigid tight-fitting hats, the destructive process being delayed only by the length and frequency of respites from this tourniquet of fashion. I have never seen a person whose habitual head-covering was soft and yielding suffer from baldness. The agriculturist, whose habit it is to wear the loosest head-coverings during the greater part of his life, has usually more hair than is conducive to comfort; but his son who has taken to city life may be bald at thirty. I think it will be noticed that the most rapid cases are among city men with close-cut hair who wear the high hat. It must fit closer, as from its height it is more liable to displacement.

The accuracy with which the hatter plies his trade is skill and energy in the wrong direction. The little instrument, the "conformator," that marks on paper the outline of one's head by which the band is molded to press more uniformly all around, is more destructive of the natural head-covering than ever were the scalping-knives of the North American Indians. It is nothing uncommon to see an old negro, who has taken to high hats, with a bald and shiny pate above and an abundant crop of hair below the hat-rim. I have long been convinced, although history is silent on this point, that old Uncle Ned—

> "Who had no hair on the top of his head,
> In the place where the wool ought to grow"—

was the favored recipient of his master's old silk hats.

Baldness is not confined to race or occupation, but it is to sex. While forty or fifty per cent of middle-aged and elderly city men show some stage of it, women are entirely exempt. They are subject to the same laws of heredity, have the same habits and occupations as men, and yet have as much hair to-day as at any previous time in the world's history. This can only be explained by the essential difference in the head-coverings of the two sexes; and yet the head-gear of women has been condemned and ridiculed in various styles of literature, principally by the high-hat sex. It may not often commend itself to one's sense of utility; it may be at one time a mere nucleus for brilliant and varied decoration, and at another an expansive and imposing structure, but it has usually the charm of novelty, sometimes of beauty, and it never destroys the growth of hair.

Man's high hat for many generations has varied within very narrow limits, and has always been ugly and unnatural. Why it should so long have held its sway it is hard to understand. An artist can not make it interesting in his work. It will not compare with the Oriental turban, the Scotch bonnet, or even the slouch hat, for comfort or graceful capabilities; but the average man will wear it long after his faith in hair tonics and restorers with seductive promises has been shattered. Still, let him remember, as he takes his after-dinner repose, that his favorite hat will certainly and inevitably extend the pasture-lands of the domestic fly.

## AMONG THE TRANSYLVANIAN SAXONS.

### I.—MARRIAGE-CUSTOMS.

WHEN the waving surface of the green oat-fields begins to assume a golden tint, when the swelling heads of Indian corn hang heavy on their stalks, and the sweating peasant prepares for the last act of his hard summer labor, then also do the good-wives in the village begin to talk of matters which have been lying dormant till now.

Well-informed people may have hinted before that such and such a youth had been seen more than once stepping in at the gate of the red or green house in the long village street, and more than one gossip had been ready to identify the speckled carnations adorning the hat of some youthful Konrad or Thomas as having been grown in the garden of a certain Anna or Maria; but after all, these had been but mere conjectures, for nothing positive could be known as yet, and ill-natured people were apt to console themselves with the reflection that St. Katherine's Day was a long way off, and that there is many a slip 'twixt cup and lip.

But now the great day which will dispel all doubt, and put an end to surmise, is approaching—that day which will destroy so many illusions and fulfill so few; for now the sun has given the last touch to the ripening grain, and soon the golden sheaves are lying piled together on the clean-shorn stubble-fields, only waiting to be carted away. Then one evening when the sun is sinking low on the horizon, and clouds of dust along the high-road announce the approach of the returning cattle, a drum is heard in the village street, and a voice proclaims aloud that "to-morrow the oats are to be fetched home." Like wildfire this news has spread throughout the village; the cry is taken up and repeated from mouth to mouth with various intonations of hope, curiosity, anticipation of triumph—"To-morrow the oats will be fetched!"

A stranger, no doubt, fails to perceive anything particularly thrill-ing about this intelligence, having no reason to suppose the bringing in of oats to be in any way more interesting than the carting of potatoes or wheat; and to the majority of land-owners the thought of to-morrow's work is chiefly connected with dry, prosaic details, such as repairing the harness and oiling the cart-wheels; but there are others in the village on whom the announcement has had an electrifying effect, and for whom the words are synonymous with love and wedding-bells.

Five or six of the young village swains, or maybe as many as eight or ten, spend that evening in a state of pleasurable bustle and excitement; busying themselves in cleaning and decking out the cart which is to fetch the oats to-morrow, furbishing up the best harness, grooming the work-horses till their coats are made to shine like satin, and plaiting up their manes with gaudy-colored ribbons. Early next morning the sound of harness-bells and the loud cracking of whips causes all curious folk to rush to their doors; and as every one is curious, the whole population is soon assembled in the street, to gaze at the sight of young Thomas, all attired in his bravest clothes, and wearing a monstrous nosegay in his cap, riding postilion on the left-hand horse, and cracking his whip with ostentatious triumph—while behind, in the gayly decorated cart, is seated a blushing maiden, who lowers her eyes in confusion at seeing herself the object of general attention—at least this is what she is supposed to do, for every well-brought-up maiden ought surely to blush and hang her head in graceful embarrassment when she first appears in the character of a bride; and, although no formal proposal has taken place, yet, by consenting to assist the young man to bring in his oats, she has virtually confessed her willingness to become his wife. Her appearance on this occasion will doubtless cause much envy and disappointment among her less fortunate companions, who peep out furtively through the chinks of the wooden shutters, at this sight of a triumph they had hoped for themselves.

"So it is the red-haired Susanna, after all, and not the miller's Agnes, as every one made sure," the gossips are saying. "And who has young Martin got on his cart, I wonder? May I never spin flax again, if it is not verily the black-haired Lisi who was all but promised to small-pox Peter of the red house!"—and so on, and so on, in endless variety, as the carts go by in procession, each one giving rise to manifold remarks and commentaries, and not one of them but leaves disappointment and heart-burnings in its rear. This custom of the maiden helping the young man to bring in his oats, and thereby signifying her willingness to become his wife, is prevalent only in a certain district in the north of Transylvania, called the *Haferland*—the land of oats—a broad expanse of country covered at harvest-time by a billowy sea of golden grain, the whole fortune of the land-owners.

In other parts of the country various other bridal customs are prevalent, as for instance in Neppendorf, a large village in the neighborhood of Hermanstadt, inhabited partly by Saxons, partly by Austrians, or Ländlers, as they call themselves. This latter race is of more recent introduction in the country than the Saxons (who count seven centuries since their emigration), having only come hither in the time of Maria-Theresa, who had summoned them to the country in order to replenish some of the Saxon colonies in danger of becoming extinct. If it is strange to note how rigidly the Saxons have kept themselves from mingling with the surrounding Magyar and Roumanian races, it is yet more curious to see how these two German races have existed side by side for over a hundred years without amalgamating—and this for no antagonistic reason, for they live together in perfect harmony, attending the same church, and conforming to the same regulations, but each preserving its own identical customs and costume. The Saxons and Ländlers have each their different parts of the church assigned to them; no Saxon woman would ever think of donning the fur cap of a Ländler matron—as little would the latter exchange her tight-fitting coat for the wide-hanging cloak of the other woman.

Until quite lately, unions have very seldom taken place between members of these two races. Only within the last twenty years, have some of the Saxon men awoke to the consciousness that the Austrian women made better and more active housewives than their own phlegmatic country-women, and have consequently sought them in marriage. Even then, when both parties are willing, and all preliminaries have been arranged, many a projected union makes shipwreck on the inflexibility of the two fathers, who will neither concede the least trifle to the other's wishes. Thus, for instance, when the Saxon father of the bridegroom demands that his future daughter-in-law should adopt Saxon attire when she becomes the wife of his son, the Austrian father, as likely as not, will take offense, and withdraw his consent at the last moment. Not a pin nor a bow will either of these two consent to sacrifice to their children's happiness. Thus many hopeful marriages have been nipped in the bud, and those few which have been accomplished have been almost invariably based on the understanding that each party retains its own attire, the daughters following the mother, the sons the father, in the matter of costume.

Among the Ländlers, the marriage proposal takes place in a way which deserves to be mentioned. The youth having secretly fixed upon the girl he would like to make his wife, prepares a new silver *thaler* (about 2*s.* 6*d.*) by winding round it a piece of bright-colored ribbon, and wrapping the whole in a clean sheet of white letter-paper. With this coin in his pocket, he repairs to the next village dance, and takes an opportunity of slipping it unobserved into the maiden's hand while they are dancing together. By no word or look does she betray any consciousness of his action, and only when back at home she produces the gift, and acquaints her parents with what has taken place.

A family council is then held as to the merits of the pretendant, and the expediency of accepting or rejecting the proposal. If the latter be decided upon, the maiden must hasten to intrust the silver coin to a near female relation of the young man, who, on receiving it back, is given thereby to understand that he has nothing further to hope in that direction ; but if three days have elapsed without the gift being returned, he is entitled to regard this as a consent, and may commence to visit in the house, on the footing of an official wooer. In cases of rejection, it is considered as a point of honor that no word should betray any hint of what has passed to the outside world—a delicate reticence one is surprised to find in these simple folk. This giving of the silver coin is probably a remnant of the old custom of buying the bride, and in many villages it is still usual to talk of the *Braut Kaufen*.

To return, however, to the land of oats, where, after the harvest has been got in successfully, the bridegroom prepares to make fast the matter, or, in other words, officially to demand the maiden's hand of her parents. It is not consistent with village etiquette, however, that the bridegroom *in spe* should apply directly to the father of his intended, but he must depute some near relation, or an intimate friend, to bring forward the request. The girl's parents, on their side, likewise appoint a representative to transmit the answer. These two ambassadors are called the *Wortmacher*, "word-makers"—sometimes also the *Hochzeitsväter*, "wedding-fathers"—and are treated with marked consideration and deference during the wedding festivities.

Much talking and speechifying are required to transact a peasant wedding correctly from beginning to end, and a fluent and eloquent *Wortmacher* is therefore a much-prized individual. Each village has its own set formulas for each of the like occasions—long-winded, pompous speeches, rigorously adhered to, and admitting of neither curtailment nor alteration. The following fragment of one of these speeches will give a correct notion of the general style of Saxon oration.

It is the *Hochzeitsväter* who, in the name of the young man's parents, speaks as follows: "A good morning to you herewith, dear neighbors, and I further wish to hear that you have rested softly this night, and been enabled to rise in health and strength this morning. And such being the case, I will thank the Almighty for his mercies toward you ; and should your health, and the peace and happiness of your household, not be as good as might be desired in every respect, so at least will I thank the Almighty God that he has made your lot endurable, and beg him further to send you in future only so much grief and trouble as you may be enabled patiently to bear at a time. Furthermore, I crave your forgiveness that I have made bold to enter your house thus early in the morning, and trust that my presence herein may in no wise inconvenience you or put you to shame, but that

I may always comport myself with honor and propriety, and that you may have no cause for displeasure in listening to the few words I have come hither to say. It has not remained unknown to me, dearest neighbor, that many years ago you were pleased to enter the holy state of matrimony, taking to yourself a beloved wife, with whom you have lived ever since in peace and happiness; and that furthermore the Almighty God, not wishing to leave you alone in your union, was pleased to bless you, not only with transitory temporal goods, but with numerous offspring—with dearly beloved children—to be your joy and comfort. And among these dearly beloved children is a daughter, who has prospered and grown up in the fear of the Lord to be a comely and virtuous maiden. And as likewise it may not be unknown to you, that many years ago we too thought fit to enter the holy state of matrimony, and that the Lord likewise was pleased to bless our union, not with temporal goods and riches, but with various beloved children, among whom is a son, who has grown up, not in a garden of roses, but in care and toil, and in fear of the Lord. And now this same son, having grown to be a man, has likewise bethought himself of entering the holy state of matrimony, and has prayed the Lord to guide him wisely in his choice, and to give him a virtuous and God-fearing companion. Therefore he has been led over mountains and valleys, through forests and rivers, over rocks and precipices, until he came to your house, and cast his eyes on the virtuous maiden, your daughter. And the Lord having been pleased to touch the hearts of the two young people with a mighty love for each other, they have begged me to come hither to crave your consent to letting them become man and wife."

Probably the young couple have grown up within sight of each other, the garden of the one father adjoining the pig-sty of the other, but the formula must be adhered to notwithstanding, and neither rocks nor precipices omitted from the programme of the speech; and even if the parents of the bride be a byword in the village for their noisy domestic quarrels, yet the little fiction of conjugal happiness must be kept up all the same, with a magnificent sacrifice of veracity to etiquette worthy of any diplomatic newspaper discussing a royal alliance. And, in point of fact, a disinterested love-match among Saxon peasants is about as rare a thing as a genuine courtship between reigning princes. Most often it is a simple business contract, arranged between the heads of the families, who each of them hope to reap advantages from the contemplated alliance. It too often happens that young girls of fifteen, and even younger, having no experience of life or of their own feelings, are persuaded by their parents to give their hand with indifference, or even dislike, to some man whose property happens to fit in conveniently; and when they urge the want of sympathy to the husband proposed, these objections are met by the practical advice of the long-sighted parents: "Try him for a time, and perhaps you will get to like him ; and if not, well, the misfortune is not so great, and it will then be time enough to seek for a divorce."

When the answer to the proposal has been a consent, then the compact is sealed by a feast, called the *Brautvertrinken* (bride-drinking), to which are invited only the nearest relations on either side, the places of honor at the head of the table being given to the two ambassadors who have transacted the business. A second banquet, of a more solemn nature, is held some four weeks later, after the rings have been exchanged in the presence of the pastor.

The 25th of November, the feast of St. Katherine, is in many districts the day selected for tying all these marriage-knots. When this is not the case, then the weddings take place in Carnival, oftenest in the week following the Sunday when the gospel of the marriage at Cana has been read in church, and Wednesday is considered the most lucky day for the purpose. The preparations for the great day occupy the best part of a week in every house which counts either a bride or a bridegroom among its inmates. There are loaves and cakes of various sorts and shapes to be baked, fowls and pigs to be slaughtered—in wealthier houses even the sacrifice of a calf or ox is considered *de rigueur* for the wedding-feast ; and when this is the case, the tongue is carefully removed, and, placed upon the best china plate, with a few laurel-leaves by way of decoration, is carried to the parsonage as the customary offering for the reverend *Herr Vater* (the pastor). The other needful provisions for the banquet are collected in the following simple manner : On the afternoon of the Sunday preceding the wedding, six young men belonging to the brotherhood are dispatched by the *Altknecht* from house to house, where, striking a resounding knock on each door, they make the village street re-echo with their cry, "*Bringt Rahm!*"—bring cream. This is an invitation which none durst refuse. All those who belong to that neighborhood are bound to send contributions in the shape of milk and cream, eggs or butter, lard or bacon, to the wedding-houses within their quarter. Every gift, even the smallest one of a couple of eggs, is received with thanks, and the bringer rewarded by a draught of wine.

Next day the women of both families assemble to bake the loaves for the wedding-feast ; the future mother-in-law of the bride-elect keeping a sharp lookout on the girl, to note whether she acquit herself creditably of her household duties. This day is in fact a sort of final examination the bride has to pass through, in order to prove herself worthy of her new dignity ; and woe to the maiden who is dilatory in mixing the dough or awkward in kneading the loaves ! While this is going on, the young men have been to the forest to fetch wood ; for it is a necessary condition that the wood for heating the oven where the wedding-loaves are baked should be brought in expressly for this occasion, even if there be small wood in plenty lying ready for use in the shed. The cart is gayly decorated with flowers and streamers, and the wood conveyed home with much noise and merriment, much in the ancient English style of bringing in the Yule-log. On their return from the forest, the court-yard gate is found to be closed, or else a rope from which are depended straw bunches and bundles, is stretched across the entrance. The women now advance with much clatter of pots and pans, and pretend to defend the yard against the besiegers; but the men tear down the rope and drive in triumphantly, each catching at a straw-bundle in passing. Some of these are found to contain cakes or apples, others only broken crockery or egg-shells. The young men sit up late into the night, splitting up the logs into suitable size for fire-wood. Their duties further consist in lighting the fire, drawing water from the well, and putting it to boil on the hearth. Thus they work till well into the small hours of the morning, now and then refreshing themselves with a hearty draught of home-made wine, the women meanwhile having lain down to rest.

When all is prepared, it is then the turn of the men to take some sleep, and they wake the girls with an old song, running somewhat as follows:

"All in the early morning gray
A lass would rise at break of day.
Arise, arise,
Fair lass, arise,
And ope your eyes,
For darkness flies,
And your true-love will come to-day.

"The lassie would so early fill
Her pitcher at the running rill.
Awake, awake,
Fair lass, awake,
The dawn doth break,
Your pitcher take,
For come to-day your true-love will."

Another song of equally ancient origin is sung the evening before the marriage, when the bride takes leave of her friends and relations:

"FAREWELL-SONG OF THE SAXON BRIDE.

"I walked beside the old church-wall,
My love stood there, but weeping all.
I greeted her, and then she spake:
'Dear love, my heart is like to break.
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on its wing plumes white as snow!'

"I set two roses in my father's land—
O father, dearest father, give me again thy hand!

I set two roses in my mother's land—
O mother, dearest mother, give me again thy hand!
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on his wing plumes white as snow!

"I set two roses in my brother's land—
O brother, dearest brother, give me again thy hand!
I set two roses in my sister's land—
O sister, dearest sister, give me again thy hand!
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on his wing plumes white as snow!

"I set again two roses under a bush of yew—
O comrades, dearest playmates, I say my last adieu!
No roses shall I set more in this my native land—
O parents, brother, comrades, give me once more your hand!
I must away, I must be gone;
When to return, God knows alone!
When to return?—when the black crow
Bears on his wing plumes white as snow!

"And when I came to the dark fir-tree,
An iron kettle my father gave me;
And when I came unto the willow,
My mother she gave me a cap and a pillow.
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"And when unto the bridge I came,
I turned me round and looked back again;
I saw no father nor mother more,
And I bitterly wept, for my heart was sore.
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"And when I came before the gate,
The bolt was drawn, and I must wait;
And when I came to the wooden bench,
They said, 'She's but a peevish wench!'
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"And when I came to the strangers' hearth,
They whispered, 'She is little worth';
And when I came before the bed,
I sighed, would I were yet a maid!
Woe's me! but those who part can tell
How sharp the pain to say farewell!

"My house is built of goodly stone,
But in these walls I feel so lone!
A mantle of finest cloth I wear,
But 'neath it an aching heart I bear.
Loud howls the wind, wild drives the snow,
Parting, oh, parting is bitterest woe!
On the belfry-tower is a trumpet shrill,
But down in the churchyard the dead lie still."

Very precise are the formalities to be observed in inviting the guests. A member of the bride's family is deputed as *Einlader* (inviter), and, invested with a brightly painted staff as insignia of his office, he goes the round of the friends and relations to be asked. It is customary to invite all kinsfolk within the sixth degree of relationship, though many of these are not expected to comply with the summons—the invitation in such cases being simply a matter of form, politely tendered on the one side, and graciously received on the other, but not meant to be taken literally as being but honorary invitations. Unless particular arrangements have been made to the contrary, it is imperative that the invitation, in order to be valid, should be repeated with all due formalities, as often as three times—the slightest negligence or divergence from this rule being severely judged and commented upon; and mortal offense has often been taken by a guest, who bitterly complains that he was only twice invited. In some villages it is, moreover, customary to invite anew for each one of the separate meals which take place during the three or four days of the wedding festivities.

Early on the wedding morning the bridegroom dispatches the *Wortman* with the *Morgengabe* (morning gift) to the bride. This consists in a pair of new shoes, to which are sometimes added other small articles, such as handkerchiefs, ribbons, a cap, apples, nuts, etc. The ambassador, in delivering over the gifts to the *Wortman* of the other party, speaks as follows: "Good-morning, Herr Wortman, and all worthy friends here assembled; the friends from our side have charged me to wish you all a very good-morning. I have further come here to remind you of the laudable custom of our fathers and grandfathers, who bethought themselves of presenting their brides with a trifling morning gift. In the same way our young master the bridegroom, not wishing to overlook this goodly patriarchal custom, has likewise sent me here with a trifling offering to his bride, trusting that this small gift may be agreeable and pleasing to you all." The bride, on her side, sends to the bridegroom a new linen shirt, sewed and embroidered with her own hands. This shirt he wears only twice—once on his wedding-morning for going to church, the second time when he is carried to his grave.

Before going to church all the men assemble at the house of the bridegroom, and the women at that of the bride. The young people only accompany the bridal pair to church—the elder members of both families remaining at home until the third invitation has been delivered. Then all together proceed to the house of the bride, where the first day's festivities are held. There is much speechifying and drinking of healths, and various meals are served up at intervals of three and four hours' distance, each guest being provided with a covered jug, which must be always kept replenished with wine. It is usual for each guest to bring a small gift or contribution to the newly-set-up household of the young couple, and these are deposited on a table spread for the purpose in the center of the court-yard; or, if the weather be unfavorable, inside the house, bride and bridegroom standing on either side to receive the gifts. First it is the bridegroom's father who, approaching the decorated table, deposits thereon a new shining plowshare, as symbol that his son must earn his bread by the sweat of his brow; then the mother advances with a new pillow, adorned with bows of colored ribbon, and silver head-pins stuck at the four corners. These gay adornments are meant to represent the pleasures and joys of the married state; but two long streamers of black ribbon, which hang down to the ground on either side, are placed there likewise, to remind the young couple of the crosses and misfortunes which must inevitably fall to their share. The other relations of the bridegroom follow in due precedence, each with a gift in his hands. Sometimes a piece of home-made linen, a colored handkerchief, or some other article of dress or decoration; sometimes a roll of sheet-iron, a pair of scissors, thread and needles, a packet of nails, or a farming or gardening implement, each one laying down his or her offering with the words, "May it be pleasing to you." Then follow the kinsfolk of the bride with similar gifts; her father presenting her with a copper caldron or a kettle, the mother with a second pillow, decorated in the same manner as the first one. Playful allusions are not unfrequently concealed in these gifts—a doll's cradle, or a young puppy-dog wrapped in swaddling-clothes, often figuring among the presents ranged on the table.

Various games and dances fill up the pauses between the meals; songs and speeches, often of a somewhat coarse and cynical nature, being a part of the usual programme. Among the games enacted at some of the Saxon peasant-weddings there is one which deserves to be mentioned, affording as it does a curious proof of the tenacity of old pagan rites and customs, transmitted by verbal tradition from one generation to the other. This is the *Rössel Tanz*, or dance of the horses, evidently founded on an ancient Scandinavian legend to be found in Snorri's "Edda." In this tale, the gods Thor and Loki came to a peasant's house in a carriage drawn by two goats or rams, and asked for a night's lodging. Thor killed the two rams, and with the peasant and his family consumed their flesh for supper. The bones were then ordered to be thrown in a heap onto the hides of the animals; but one of the peasant's sons had, in eating, broken open a bone, in order to get at the marrow within, and next morning when the god commanded the goats to get up, one of them limped on the hind-leg, because of the broken bone. At first Thor was in a great rage, and threatened to destroy the whole family, but finally allowed himself to be pacified, and accepted the two sons as hostages.

In the peasant drama we have now before us, the gods Thor and Loki are replaced by a colonel and a lieutenant-colonel, and, instead of two goats, there are two horses and one goat; also the two sons of the peasants are here designated as Wallachians. Everything is of course much distorted and changed, but still all the principal features of the drama, which space forbids me here to enlarge upon, are clearly recognizable—the killing of the goat and its subsequent resurrection, the rage of the colonel, and the transferment of the two Wallachians into his service, being all parts of the performance.

At midnight, or sometimes later, when the guests are about to depart, there prevails in some villages a custom which goes by the name of *den Borten abtanzen*—dancing down the bride's crown or head-dress. This head-covering, which can only be described as resembling a chimney-pot hat without brim or crown, and from which depend long streamers of ribbon reaching to the ground, is the sign of her maidenhood, which she must lay aside now that she has become a wife, and it is danced off in the following manner: All the married women present, except perhaps a few very old and decrepit ones, join hands, the two brideswomen taking the bride between them. Thus forming a wide circle, they dance backward and forward, round and round the room, sometimes forming a knot in the center, sometimes far apart with outstretched arms, till suddenly, either by accident or on purpose, the chain is broken through at one place, which is the signal for all to rush out into the court-yard, still holding hands. From some dark corner there now springs unexpectedly a stealthy robber, one of the bridesmen, who has been lying there in wait to rob the bride of her crown. Sometimes she is defended by two brothers or relations, who, dealing out blows with twisted handkerchiefs or towels, endeavor to keep the thief at a distance; but the struggle always ends with the loss of the head-dress, which the young matron bewails with many tears and sobs. The brideswomen now solemnly invest her with her new head-gear, which consists in a snowy cap and veil, held together by silver or jeweled pins, which are sometimes of considerable value.

When the young couple go to church the day after the wedding, they are met at the church-door by a group of masked figures who surround them, singing and hooting, and playfully endeavor to separate the young matron from her husband. If they succeed in so doing, then he must win her back in a hand-to-hand fight with his adversaries, or else he must give a piece of money as her ransom. In general it is considered a bad omen for the married life of the young couple if the wife be separated from her husband on this occasion ; therefore it is customary for the young husband to take his stand close by the church-door while his wife is praying within, and then be ready to catch hold of her as soon as she steps outside. For greater precaution, the man often holds her round the waist with both hands during the dance which immediately takes place before the church, and at which they assist merely as spectators, taking no active part, as it is not considered seemly to dance in the church attire.

As commonly several couples are married at the same time, it is usual for each separate wedding-party to bring its own band of music, and dance thus independently of the others. On the occasion of a triple wedding I lately witnessed, it was very amusing to watch the three wedding-parties coming down the street, each accelerating its pace till it came to be a sort of race up to the church-door to secure the best dancing-place. The ground being rough and slanting, there was only one spot where anything like a flat dancing floor could be obtained, and the winning party at once secured this enviable position, while the others had to put up with an inclined plane or a few hillocks accidenting their ball-room floor. The ten to sixteen couples belonging to each wedding-party are inclosed in a ring of bystanders, each rival band of music playing away with heroic disregard for the scorched ears of the listeners. "Polka!" calls out the first group ; "*Walzer!*" roars the second, for it is a point of honor that each party should display a noble independence in taking its own line of action ; and if, out of mere coincidence, two of the bands happen to strike up the self-same tune, one of them is sure to change to something totally different as soon as aware of the unfortunate mistake—the caterwauling effect produced by this system baffling all description. "This is nothing at all," said the worthy pastor, from whose garden I was overlooking the scene, laughing at the evident dismay with which I endeavored to stop my ears. "Sometimes we have eight or ten weddings at a time, each with their own fiddlers. That is something worth hearing indeed!" The rest of that day is spent much in the same manner as the former one, only this time in the house of the bridegroom's parents.

Among the customs attached to this first day of wedded life is that of breaking the distaff. If the young matron can succeed in doing so at one stroke across her knee, then she will be sure to have strong and healthy sons. If the reverse, she has only girls to expect.

The third day is called the finishing-up day, each of the two families assembling its own friends and relations to consume the provisions remaining over from the former banquet, and at the same time to wash up the cooking-utensils and the crockery, restoring whatever has been borrowed from neighbors in the shape of plates, wine-jugs, etc., the new-married couple joining the entertainment, now at the one, now at the other house. This day is the closing of the wedding festivities, which have kept both families in a state of unusual bustle and excitement for fully a week. Everything now returns to every-day order and regularity, the young couple usually taking up their abode in a small back-room in the house of the young man's parents, and putting off till the following spring the important business of setting to build a house of their own. Dancing and feasting are now at an end, and henceforward the earnest of life begins.—*Blackwood's Magazine.*

[*To be continued.*]

## WILLIAM BABCOCK HAZEN.

By Professor CLEVELAND ABBE.

THE sudden death of Brigadier-General William B. Hazen, Chief Signal-Officer of the United States Army, which occurred on Sunday, January 16, 1887, deprived the country of one of its most distinguished officers, and the Signal Corps of a chief who took a broad view of its duties and relations to the world of business and science.

General William Babcock Hazen was the great-grandson of Thomas Hazen, who was born in 1719, and who was himself great-grandson of Edward Hazen, who emigrated from England before 1649, and settled at Rowley, Massachusetts, where he died in 1683.

The descendants of Edward Hazen include many names eminent in business, theology, and war; energy, industry, and strong convictions characterize the members of the family on all sides.

General Hazen was born at West Hartford, Vermont, September 27, 1830. While he was yet a child, his parents removed to Hiram, Portage County, Ohio. In 1851 he was appointed from Ohio as a cadet to the United States Military Academy at West Point, from which he graduated July 1, 1855. He was assigned to the Eighth United States Infantry, and spent the next five years in frontier service, more especially against the Indians in California, Oregon, and Texas, in which service he displayed an energy and bravery that have been characteristic of his life. His record during these years embraces constant fights and pursuits. He was twice severely wounded; and, by virtue of the latter, he was, in January, 1860, by the surgeon's order, granted a leave of absence as being unfit for duty. In consequence of this, he was at the North while his regiment was in Texas at the breaking out of the rebellion; the regiment having been captured and its officers released on parole, he alone was unembarrassed by the parole, and was able to offer his services to the Union army. He was at once assigned as temporary instructor at West Point. In May, 1861, he became captain of the Eighth Infantry, of the regular army, and in October was made colonel of the Forty-first Regiment of Ohio Infantry in the volunteer army. During the war he distinguished himself on many occasions, and his commission as major-general was granted him December 13, 1864, for "specific distinguished services"—i. e., "for long and continued services of the highest character, and for special gallantry and service at Fort McAllister." This placed him fifth in a list of twenty-four officers who had received commissions for distinguished service.

He continued serving on the frontier territories, north and west, and was especially active in Indian affairs until 1870, in which year he was allowed leave of absence to visit the seat of war in Europe. The results of his observations and studies during his six months' absence are embraced in a volume entitled "The School and the Army in Germany and France, with a Diary of Siege-Life at Versailles," New York, 1872. This volume contains a very interesting sketch of Bismarck and Bismarck's own account of the state of affairs in Europe. It contains especially a fair criticism of the relative excellencies of the German and French systems, both civil and military ; in a special chapter on that subject, he incidentally brought out more prominently some weak points in our own military organization. It would seem that the courage displayed so brilliantly on the battle-field frequently nerved him to utter not only these but other fearless criticisms of things that were palpably wrong, and some of which have since been corrected.

He was married February 15, 1871, to Millie, daughter of the Hon. Washington McLean, of Cincinnati, who with one son survives him.

On his return from Europe in 1871, he returned to duty in the Indian Territory, and was with his regiment in Kansas and Dakota, except for a short absence, until December 15, 1880, when he was by President Hayes appointed brigadier-general and chief signal-officer, and since then has been stationed at Washington. The absence just referred to was occasioned by his again visiting Europe as military *attaché* to the United States legation at Vienna, for the purpose of studying the operations of European armies during the Turco-Russian war. He was absent on this service from December, 1876, to June, 1877, and the results of his observations were published subsequently in a highly interesting popular volume.

The general account of his activity during the war of the rebellion was published by him in his "Narrative of Military Service," Boston, 1885.

His letters and pamphlets on the "Bad Lands" show that for many years General Hazen had been studying the relations of meteorology and agriculture ; upon his appointment as chief signal-officer he became indefatigable in his efforts to improve the military and departmental relations of the Signal Service, its scientific character, its practical usefulness to farmers and herders, and its popular influence. His labors in Washington stirred up most virulent opponents—first, when it became necessary for him to expose and prosecute the corruption of Captain Howgate; again, when it became necessary in self-defense to expose the true reasons of the failure of the War Department to properly support and succor the Signal-Service Expedition to Fort Conger; and, again, when he had occasion to defend the advantages of the military character of the combined Signal Service and Weather Bureau organization against those who would take it from the army without making a proper provision for its work in any other department. The records of his successful defense against attacks prompted by implacable hate, official stubbornness, and personal ignorance are to be found in the proceedings of "Courts-Martial," "Courts of Inquiry," "Committee of Congress on Expenditure," and especially in the "Testimony before the Joint Commission to consider the Present Organization of the Signal Service," etc., which latter voluminous report with testimony was printed in June, 1886.

General Hazen's interest in meteorology, as before said, properly dates back earlier than 1873, at which time he prepared a letter "On our Barren Lands, or the Interior of the United States, west of the One Hundredth Meridian and east of the Sierra Nevadas." This was published in the "New York Tribune," February 27, 1874, and led to a discussion in that paper and in the "Minneapolis Tribune" between himself and General A. A. Custer, which is summarized in a pamphlet of the above title published by Robert Clarke & Co., of Cincinnati, in 1875. The motive of General Hazen evidently was the protection of investors and settlers against the too glowing accounts, which amounted to virtual misrepresentation, on the part of the employés of the Northern Pacific Railroad; his compilation of climatological data, and his statement of personal experience, based on long residence in that region, largely contributed to prevent blind emigration into an inhospitable country, while they doubtless also contributed to direct attention to the really valuable portions of our Northwest territory, so that the permanent development of that portion of the United States has been furthered by his action. It was, however, at the time, on his part, a very characteristic, outspoken exposition of what seemed to him a fraud and imposition perpetrated by unscrupulous financiers upon foreign immigrants and over-confiding settlers and investors.

During his connection with the Signal-Office, General Hazen frequently took occasion to show his appreciation of the fact that the weather predictions were essentially not a matter of mere military routine, but that in all departments the office had need of the work of specially trained experts; that it was a mistake to shut one's eyes to the fact that, in a matter of applied science like this, some of those whom the scientific world recognizes as meteorologists and physicists must be employed and be required to keep the chief fully informed of the progress of science. Perhaps this is best exemplified by a quotation from his letter of March 24, 1886, addressed to a Committee of the House on Expenditures of the War Department: "At the beginning of the work of the Signal Service, the duty of giving notice of the approach and force of storms and floods for the benefit of commerce and agriculture throughout the United States implied that the notices should be correct, reliable, and timely, as none others could possibly be of benefit; it was, therefore, absolutely necessary to provide for the careful study of the atmosphere. On my accession, I found every evidence, from popular criticism, that still further progress in weather predictions was expected. I therefore emphasized especially the necessity of the study of the instruments and methods of observing and the investigation of the laws of the changes going on in the atmosphere. . . . It is evident by these successive steps that, in addition to knowledge gained for current work, the office is powerfully contributing toward the establishment of a deductive science of meteorology which will eventually give us a solid, rational basis for predictions, thereby improving on the empirical rules by which predictions have generally been made hitherto." And he adds that he was led more especially to assist in the researches on the sun's heat by reason of the encouragement given him by the late President Garfield, whose "last words to me were, 'Give both hands of fellowship and aid to scientific men.'"

As a further illustration of General Hazen's appreciation of the scientific needs of the office, must be noted his appointment of Professor William Ferrel as meteorologist, and of Professor T. C. Mendenhall as electrician; to the latter, all matters relating to standards, instruments, and instrumental research were also committed. Nor did he stop here, but, by appointing several younger men to positions as junior professors, he largely increased the amount of study and research that the office was able to perform, and, by publishing a series of professional papers and smaller notes, he took the final steps necessary to stimulate every man to do his best. Laboring in this same direction, he sought to elevate the intelligence and scientific training of the Signal Corps proper, by enlisting college graduates as far as possible, by extending the course of instruction for observers, and by establishing a course of higher instruction for commissioned officers.

In still another direction General Hazen showed his affiliation with scientific interests, namely, by his desire to conform as thoroughly as possible to the recommendations of the International Meteorological Conferences. These recommendations, as soon as received in the printed minutes of the conferences, were, by General Hazen's orders, carefully examined, and instructions at once prepared calculated to introduce methods of observation and publication in conformity with the recommendations of the leading meteorologists of the world.

Among the items specially noteworthy, wherein General Hazen developed new paths of activity for this service, may be mentioned the study of local thunder-storms and tornadoes, which were respectively assigned to Professor Hazen and Lieutenant Finley so far as a collection of general statistics is concerned; and to Professor Mendenhall, so far as concerns the electrical phenomena proper. The study of atmospheric electricity was especially authorized in 1884, by an order of the Secretary of War, transmitting the resolutions of the International Electrical Conference held in Paris the preceding year. After full consultations with numerous electricians throughout the country, General Hazen decided that a daily map of electric potential showing lines of equi-potential similar to the iso-barometric lines, offered hopeful prospect of eventually leading to a method of predicting the formation and motion of thunder-storms and tornadoes. But the methods of observation, and the apparatus, needed first to be determined upon, after careful experimental work. This whole matter was, therefore, in 1885, committed to the hands of Professor Mendenhall.

Perhaps the most important item in internal administration, so far as it affects the permanent scientific value of the office-work, was the effort heartily furthered by General Hazen to improve the accuracy and international comparability of our instrumental equipment. The standards of the International Bureau of Weights and Measures were recognized by him as being the proper legal standards for this office, and every effort made to determine the corrections needed to reduce the past as well as the current meteorological observations of the Signal-Service to agree therewith.

Perhaps the generous breadth of General Hazen's views, the absence of injurious jealousies, and his confidence in the principle that the Weather Bureau would be strengthened by the widest diffusion of an intelligent appreciation of meteorology, are in nothing more clearly shown than in the earnestness with which he stimulated the formation of state weather services, and encouraged the study of meteorology in every school and college. He was painfully impressed by the disastrous influence upon individuals and business of the wide-spread and utterly absurd predictions of the storms and weather of March 9, 1884, which were distributed broadcast throughout the country, and emanated from Mr. Vennor. He saw clearly that all this harm could only be prevented by increasing the intelligence of the people in scientific matters, and heartily indorsed every effort to diffuse a more correct idea as to what constituted legitimate meteorology.

Although his duties demanded the maintenance of a great central office at Washington, yet General Hazen realized that centralization could easily be carried too far in scientific matters, and would thus react injuriously upon the work of his office. He was desirous of rapid progress in all directions, and, to secure this, welcomed every prospect of co-operation with other institutions as well as with individuals. One of his first acts was the request for co-operation on the part of the National Academy of Sciences. He improved the opportunity to help Professor Langley in the determination of the absorbing power of the atmosphere ; he accepted Professor King's offer to carry observers on his balloon-voyages ; he heartily furthered Lieutenant Greely's efforts to maintain an international polar station, and joined with the Coast Survey in establishing a similar station, under Lieutenant Ray, at the northern point of Alaska ; he co-operated with the Bureau of Navigation in securing weather reports from the ocean; he powerfully assisted the Metrological Society in its labors for the reformation of our complicated system of local times, the result of which was the adoption by the country of the present simple system of standard meridians one hour apart.

Equally successful was he in his efforts to co-operate in various methods of disseminating and utilizing the knowledge obtained by the Weather Bureau for the benefit of the business interests of the country. With the telegraph companies he published the daily telegraph bulletin. Through the railroad companies he displayed the railroad train-signals visible to every farmer along the railroads. With local boards of trade and other business interests he elaborated our system of flood-warnings in the river-valleys.

General Hazen was especially clear in his views as to the importance of giving personal credit to each man for his own personal work. Routine work was credited to the assistants in charge and not to the impersonal office; having assigned a special work to the best man available, he took pains to give him the credit and make him personally responsible for its success, thus securing more enthusiasm in the work.

This notice of a few prominent features in the intense activity of General Hazen's life seems eulogistic rather than historical; but to the contrary, the fact is that military life rarely offers a position that requires the promotion of any special science, and still more rarely do official or military circles present an officer who so thoroughly desired, as far as allowable, to relax stringent military law and liberally interpret cumbersome official regulations, so that scientific men might successfully promote their special work.

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M. Grand 'Eury has propounded a theory that coal was originally a liquid generated by the decomposition of inferior vegetation in an atmosphere highly charged with carbonic acid. The carbon of the jelly-like mass thus formed, after passing through various transformations into asphalt, petroleum, bitumen, etc., finally assumed the form of coal. The author cites various facts connected with the occurrence of coal, which, he thinks, are better explained on his theory than by the usual one.

## SKETCH OF JAMES FERGUSSON.

MR. JAMES FERGUSSON, writer on architecture and its history, who died January 9, 1886, was distinguished for the diligence with which he prosecuted his researches, and for the originality of his conclusions. Although the subject to which he chiefly directed his attention is usually classed among the arts rather than the sciences, he brought so philosophical a spirit to its study; so prominently regarded it in its archæological and anthropological aspect, and so combined with the questions which it raised those which relate to the development of human civilization; and so faithfully in all his work upon it strove, as he expresses the thought, to raise its study from the "dry details of measurements to the dignity of an historical science," that he may well be considered entitled to a place among scientific men.

Mr. Fergusson was born at Ayr, in Scotland, in 1808, the son of an army-surgeon, who had seen active service abroad, "who had a liking for engineering as applied to architecture," and who wrote on the construction of hospitals. He was taught in the High School at Edinburgh and in a private school at Hounslow, and became a resident of England by the removal of his father to Windsor. When he had reached an age to start out for himself, he went to India, with a determination to work steadily in business for ten years, and then to retire with such fortune as he might have been able to make. He associated himself with a mercantile house in Calcutta, from which he withdrew his interest in time to escape being involved in its failure, and afterward, having filled for a short time two or three administrative positions, became an indigo-planter in Bengal.

He had, however, already developed a high interest in art, and found in India an attractive field, and novel in many of its features, for the cultivation of this taste and the increase of his knowledge. He made a thorough exploration of the whole peninsula, traveling, for the most part, on camel-back, and armed with a *camera lucida*, with which he was an expert draughtsman. His attention was directed early to the rock-cut temples of Ajunta, Ellora, and other places. "His perspicacity," says a critic of his life in the "Athenæum," "soon guided him to a true explanation of the origin and character of these remains, his familiarity with Indian life and modes of worship gave insight as to the intentions of the excavators, and large comparisons enabled him to decide on the positive as well as the relative ages of these astonishing works. . . . In effect, the first fruit of his researches was a denial that the temples were architectural at all in the ordinary sense of that term." His first publication of the results of these studies was the "Illustrations of the Rock-cut Temples of India," which appeared in

1845. It was followed, in 1847, by "Picturesque Illustrations of Ancient Architecture in Hindostan," and at later dates by contributions to the works of Captain Hart, Mr. Hope, and Meadows Taylor, on special or local features in the architecture of India. Another work connected with this subject may be mentioned here—"Archæology in India," published in 1884, which was called forth by strictures on his views, and had much of the controversial in its composition. Mr. Fergusson's studies on these subjects, which he believed were prosecuted under singularly favorable circumstances, assumed such a character that he could say: "Not only was I able to extend my personal observations to the examples found in almost all the countries between China and the Atlantic shore, but I lived familiarly among a people who were still practicing their traditional art on the same principles as those which guided the architects of the middle ages in the production of similar but scarcely more beautiful or more original works. With these antecedents, I found myself in possession of a considerable amount of information regarding buildings which had not previously been described, and—what I considered of more value—of an insight into the theory of the art, which was certainly more novel." On the strength of this knowledge he published, in 1849, "An Historical Inquiry into the Principles of True Beauty in Art, with Especial Reference to Architecture." The book was not written in a popular style, and did not sell. The matter of this essay was afterward written over in a more engaging style, into the "Illustrated Hand-Book of Architecture," a concise and popular account of the different styles prevailing in all ages and countries, which was published in 1855. This book was successful. Having gone out of print, it was again rewritten in an entirely new form, and the result of the remodeling appeared in 1865, as the "History of Architecture in All Countries from the Earliest Times to the Present Day," in three volumes, afterward enlarged into four. This book is described by a critic in the "Academy" as practically standing "quite alone in the English language as an encyclopædia of architecture; and though its immensely wide scope necessarily forced its author to depend largely on the drawings and statements of others, and so caused many inaccuracies to creep into the text, yet on the whole it is a work of real and, to all appearance, lasting value." The purpose of the work was declared to be to write a universal history of architecture, in which each style shall occupy exactly that amount of space which the extent of the buildings or their merit would appear to justify; and to apply one law of criticism to all styles, ancient and modern, Eastern and Western, showing why one building has been successful or another failed, by a reference to those principles of design in architecture which seem to be universal and are easily understood. While the method of the "Hand-Book" was topographical, the historical method was adopted in the "History" as the one better suited to the purposes of giving a general view of the whole of the subject, and of tracing the connection of the various parts with one another. A great deal had recently been added to knowledge on the subject by the publication of special treatises in particular departments of it, and photography and the careful study of ancient monuments and buildings had furnished means of reaching more correct conclusions. Stress was laid on this last point, for so long, the author said, as our researches are confined to what the ancient authors have written, "many important problems remain unsolved, and must ever remain as unsolvable as they have hitherto proved"; and in the countries and times to which the monuments appertained, "men who had a hankering after immortality were forced to build their aspirations into the walls of their tombs or of their temples. Those who had poetry in their souls, in nine cases out of ten expressed it by the more familiar vehicle of sculpture or painting rather than in writing. To me it appears that to neglect these in trying to understand the manners and customs or the history of an ancient people, is to throw away one half, and generally the most valuable half, in some cases the whole, of the evidence bearing on the subject."

In the second edition of the "History," which was published in 1874, Mr. Fergusson called attention to the need of a comprehensive and systematic study of American architecture, saying: "What is really wanted is that some one should make himself personally acquainted with all the various styles existing between the upper waters of the Colorado and the Desert of Atacama to such an extent as to be able to establish the relative sequence of their dates, and to detect affinities when they exist, or to point out differences that escape the casual observer. . . . The problem is, in fact, identical with that presented to Indian antiquaries some thirty years ago. At that time we knew less of the history of Indian architecture than we now know of American, but at the present day the date of every building and every cave in India can be determined with absolute certainty to within fifty, or at the outside one hundred, years; the sequence is everywhere certain, and all can be referred to the race and religion that practiced that peculiar style. . . . What has been done for India could, I am convinced, easily be accomplished for America, and with even more satisfactory and more important results to the history and ethnography of that great country. The subject is well worthy the attention of any one who may undertake it, as it is the only means we now know of by which the ancient history of the country can be recovered from the darkness that now enshrouds it, and the connection of the Old World with the New—if any existed—can be traced, but it is practically the only chapter in the history of architecture which remains to be written."

Mr. Fergusson had intended to include in his "History" chapters on what were known as Celtic or Druidical remains. But, when the subject came to be looked into, it was found that the whole was such a confused mass of conflicting theories and dreams, that no facts or dates were so established that they could be treated as historical. The materials which had been collected on this subject were, therefore, worked into another book, which appeared in 1872, as "Rude Stone Monuments." Its character was rather argumentative than historical; it presented the view that the style of architecture to which the monuments described belong "is a style, like Gothic, Grecian, Egyptian, Buddhist, or any other. It has a beginning, and middle, and an end; and though we can not make out the sequence in all its details, this at least seems clear—that there is no great hiatus; nor is it that one part is historic, while the other belongs to prehistoric times. All belong to the one epoch or the other. Either it is that Stonehenge and Avebury, and all such, are the temples of a race so ancient as to be beyond the ken of mortal men, or they are the sepulchral monument of a people who lived so nearly within the limits of the true historic times that their story can easily be recovered." The author's belief was that they were of Roman and post-Roman times. These conclusions were disputed; Sir John Lubbock pronounced some of them hasty and untenable, and some seemingly inconsistent with one another; but for all that he accorded the book "the merit of being a rich and trustworthy storehouse of facts." Another critic, Mr. S. P. Oliver, while he accepted Sir John Lubbock's verdict, predicted that the book would doubtless become a text-book on that section of archæology which pertains to megalithic structures.

In his treatise on "Tree and Serpent Worship," which was published in 1868, and in a second edition in 1873, Mr. Fergusson, availing himself of the results of his laborious researches in India, presented some original views respecting the symbolism of the ancient religions, and the primitive conceptions from which they may have arisen.

Another line of work in which Mr. Fergusson distinguished himself by his diligence and the novelty of some of his conclusions was that of Jewish, Assyrian, and classical antiquities, the fruits of his studies in which were presented in a variety of publications and shapes. In the "Topography of Jerusalem" he set forth some theories in regard to the true site of the temple which appear to have been set aside by later explorations. This was followed by other papers and articles respecting Jerusalem and its sites. In "The Palaces of Nineveh and Persepolis restored" he attempted an exposition of the architecture of Western Asia from the earliest period to the age of Alexander. By papers and suggestions he advised and assisted Sir Henry Layard in restoring the plans and explaining the designs of the temples of Nineveh; and he did a like service for Dr. Schliemann in unraveling the plans of Troy, Mycenæ, and Tiryns. The value of these services was freely acknowledged by Dr. Schliemann, who, dedicating his "Tiryns" to him, styled him "the historian of architecture, eminent alike for his knowledge of art and for the original genius which he has applied to the solution of some of its most difficult problems." He studied the manner in which the Parthenon (and presumably other ancient temples) was lighted, and came out with a conclusion different from any which had been currently held before. It had been supposed that the lighting of the building was hypæthral — that is, through an opening in the roof ; Dr. Fergusson maintained that the light was admitted through side-openings, like the clearstory of a cathedral, while the sun and rain were excluded ; and the last work he published—"the Parthenon"—presented the considerations in favor of this view.

From 1863 to 1866, Mr. Fergusson was, with the exception of the year 1872, a member of the Council of the Royal Geographical Society. When filling this office, says Major-General Sir Frederick Goldsmid, his advice and assistance, always tendered with readiness, were of a most useful and practical kind, whether in advancement of the science to which the society was dedicated, or in minor details connected with the buildings in which its deliberations were held. In this society he was more frequently heard in participation in the discussions than in the reading of papers ; but one of his papers, "On the Delta of the Ganges and the Natural Law regulating the Course of Rivers," was pronounced a most original and valuable contribution to science.

He bestowed much attention on military engineering and fortification. He set forth as early as 1849, in his "New System of Fortification," the advantages of earthworks as defenses against artillery, which have since been conclusively proved many times in real battle. He was appointed, in 1857, a member of the Royal Commission to inquire into the defenses of the United Kingdom ; and he afterward served for eight months, or till the retirement of his chief, as assistant to Sir Henry Layard, Chief Commissioner of Public Works.

Regarding the value of Dr. Fergusson's work, we have the carefully measured estimate in the "Athenæum," that "his acute analysis and criticism, always intended to illustrate the perfection of common sense, did not invariably carry conviction ; . . . yet his clear, laborious, and searching methods commanded attention, and never failed to gain respect. Those who could not agree with his views upon the beauty and æsthetic value of Indian architecture, nor accept his version of the history of the holy places at Jerusalem, acknowledged the authority of his masterly and careful studies of whatever kind."

# CORRESPONDENCE.

### "FUNCTIONS OF THE STATE."

*Editor Popular Science Monthly:*

THOUGH usually reading with approbation the "Editor's Table" in "The Popular Science Monthly," I can not refrain from expressing a decided dissent from the position taken in the latter part of an editorial in the March number entitled "Functions of the State." The opinion therein advanced is that "education is no part of the functions of the State, and that it would be better, therefore, to leave it in the hands of the family, even though the result were to show in the course of a few years a larger proportion than now of that kind of illiteracy which consists in not being able to read or write." In other words, as I understand the editor's meaning, he would do away with our present public-school system, now regarded by educators and tax-payers generally as the most effective means of promoting popular education, and substitute therefor a *laissez-faire* or go-as-you-please system of private education. That is certainly a revolutionary proposition. Is it logical or tenable?

The theory of the common-school system, by which the wealthy (tax-payers) are made to bear the burden of educating the children of the poor, is, of course, that under this system more children are taught the rudiments of knowledge, and that this teaching is, as a whole, more effective than would be the case if the matter were left to individual action; that is, that more knowledge is imparted to the people in a given time than would be possible by any other means. Back of this is the more fundamental assumption that knowledge is good; that as the antagonist of ignorance it is also the enemy of crime and disorder. Can the truth of either of these propositions be successfully disputed?

It needs no figures to prove that ignorance is the mother of crime. It is a part of the common experience of every man. The patrons of bar-rooms, the criminal classes in city and country, the inmates of prisons, are, as a rule, the uneducated. Educate the children of these people, teach them the great lesson that happiness, prosperity, and success depend upon right living (to the establishment of this truth all true education tends), and you decrease crime.

Again, can it be denied that anatomical and physiological ignorance is the parent of disease? Or that ignorance of political economy gives birth to financial heresies, to the enactment of unjust or unwise laws, to mistaken ideas concerning real-estate tenure, to socialism, communism, and anarchism?

If it be admitted, then, that the spread of knowledge is conducive to the public weal, the only question remaining is as to the efficacy of the present school system to that end. And here, again, it is not necessary to appeal to statistics to prove that a large majority of the people in any country would be pecuniarily unable to educate their children without some form of State aid. And of those who could afford it a large fraction would lack the disposition to do so. It must be evident to any observer that were all laws relating to instruction at public expense to be repealed, and the entire matter left to the individual, popular schooling would become a thing of the past. Illiteracy among the masses would be the rule, and education would be confined to a comparative few among the well-to-do. A well-defined educated class would gradually be formed, and a class spirit would be fostered contrary to the central idea of a democratic society. The brotherhood of cranks would increase and multiply, all kinds of isms would flourish and become powerful, and especially the "labor element," with its demands, would assume the proportions of a national danger, and perhaps succeed in time in bringing about revolution and anarchy.

I think I have not put the case too strongly. That our present educational methods are in many respects faulty, and that there is urgent need of reform in the manner in which the theory of public education is put in practice, I do not deny. The wisdom of compulsory educational laws may be questioned. But it seems to me plain that the theory itself is based upon correct scientific principles. If there is any public function which an organized society is justified in performing, it is to take measures for the elimination of elements within itself inimical to its own existence. And the surest and cheapest way to accomplish this is to disseminate the simple branches of knowledge among its young, to an extent that will inspire them with a desire for higher truth, and furnish them with a sufficient mental equipment for its acquirement and digestion. E. S. Marsh.

Brandon, Vermont, *February* 28, 1887.

### A CORRECTION.

*Editor Popular Science Monthly:*

Sir: In your March issue you say, referring to my article on socialism, in the January "Scribner": "He apparently approves of the exemption of church property from taxation, in so far as the practice is grounded on a belief that the interests of public order will thereby be subserved."

I do not see why you should say this. There is nothing in my article to justify it. That article was written, not to discuss church exemption, but to define and illustrate socialism. Church exemption was only referred to so far as to answer the inquiry, Is it socialistic? Now, my definition of a socialistic measure—say, a legislative act—makes the motive and the objective a part of the act, equally with the positive provisions thereof; and by that definition, the exemption of church property from taxation, with a view to the promotion of good order, the reforming of vice and violence, the security of property, is not socialistic. It may be unwise; it may be monstrously foolish. On that point I had nothing to say, because I was writing on socialism. You express "surprise" that I should mention the argument in favor of church exemption, without denouncing it as hollow, unscientific, and a manifest begging of the question. Pardon me for suggesting that, whatever may be true of journals of art or theology, a journal maintained in the interests of science should encourage writers in sticking to their subjects, for the time being, and not going off erratically to discuss —much less, to denounce—views which regard matters wholly outside their chosen field of inquiry. Having decided that the measure in question was not socialistic, I had nothing more to do with it in an article on socialism.

It was perfectly competent to "The Popular Science Monthly" to reject my definition of socialism; but it should not blame me for adhering closely to that definition, when once adopted. Respectfully, yours,

FRANCIS A. WALKER.

BOSTON, *March* 18, 1887.

We publish the above letter as a matter of simple justice to its author. It seems that we put a wrong construction on that portion of his article in the January "Scribner" dealing with the question of the non-taxation of church property. All we can say is that we gave his article a tolerably attentive reading at the time, and understood him to give at least an implied approval of the policy of non-taxation, provided only the claim made for it that it was favorable to the preservation of public order was urged in good faith. We are now asked to observe that all he said was that the policy in question—the proviso in question holding good—could not properly be described as socialistic. We accept the correction; but we think that so practiced a writer as General Walker might have guarded more effectually against misapprehension if he had tried. These were his exact words:

"The prevention of violence and crime is the proper function of the state, according to the lowest views that can be taken of it; and, if a certain amount of encouragement and assistance is extended to religious bodies genuinely in this interest, no invasion of individual initiative and enterprise can properly be complained of."

Our correspondent thinks that it would have been highly unscientific on his part to have dropped so much as a hint as to the completely unverified character of the claim supposed to be put forward on behalf of the policy referred to. It strikes us that the case is one in which Science might have sacrificed a little of its dignity for the sake of a public benefit. However that may be, we are glad to have it on record that General Walker does not commit himself in any manner, or to any extent, to the doctrine that church property ought to be exempt from taxation. It is more important and satisfactory to know this than to know that he does not regard the doctrine as a socialistic one; especially when we consider how little difference it makes, from General Walker's point of view, whether a doctrine is socialistic or not.—*Editor.*

# EDITOR'S TABLE.

## *STATE EDUCATION.*

WE publish elsewhere a letter calling in question the opinion expressed in these columns last month that education was properly a matter for the family rather than for the state —for private enterprise rather than for governmental control. The arguments used by our correspondent have, we need hardly say, long been familiar to us; and therefore their restatement does not affect our conclusions on the question at issue. It is, however, due to our correspondent, and perhaps also to our readers, to deal briefly with some of the points raised in his letter.

He says that the alternative to state education is the "*laissez-faire*, or go-as-you-please system." We ask whether everything that is left to private enterprise can properly be said to be left to a "go-as-you-please system." If so, all we can say is, that the system in question, call it as you will, produces some very good and marvelous results. *Laissez-faire* has made the railway systems of this country and of England; it has made great steamship companies and telegraph companies and life-insurance companies; it has organized the most gigantic industrial and commercial enterprises, and provided in the most wonderful manner for the whole material life of the community. To say that a social function not controlled by the Government must necessarily fall into disorder (which, of course, is what the term "go-as-you-please" is meant to imply), is to go further than our correspondent probably meant to go, or than any sensible man would go; and yet the contrast he seeks to draw between governmental methods and the go-as-you-please system involves this as a general principle. But is there no go-as-you-please in governmental methods? Is our public-school system free from the intrusion of vicious political influences? Are not teachers in different states agitating at this very moment for some greater security in their positions than can be enjoyed under existing laws? And do not they feel that their usefulness is continually being impaired by their dependence on the favor of trustees who are themselves dependent on the political machine? We know of no go-as-you-please that is more destitute of all moral impulse or direction than the go-as-you-please of municipal politics. It is really go-as-the-boss-pleases, and the boss goes for the offices and the plunder by the most direct road! We attach the educational interests of the community to precisely the faultiest part of our whole political system, and then exult that we have rescued it from the *régime* of go-as-you-please! Well, when we say "we," we must be allowed to exclude ourselves, for *we* don't.

Our proposition is characterized by our correspondent as "revolutionary." We think the word too strong; call it radical if you like, seeing that it goes to the root of things; but we think it a mild form of revolution to propose that people should not look to the Government to educate them. We should like to see the people educating the Government; and the people could do this if they would only first educate themselves.

Our correspondent has the true democratic spirit, and does not want to see classes formed in this free country; nevertheless, he talks of "the poor" as people whose children ought to be educated at the expense of the "wealthy tax-payers." If this is not establishing classes with a vengeance we don't know what is. We hold that nothing would tend more to raise the spirit of the poor and enhance their sense of citizenship and of social equality than to feel that they did *not* depend on the rich for the education of their children, but that they provided for that all-important object by their own labor, and, if necessary, self-denial. If the rich are to contribute of their substance to the poor under legal compulsion, why should education in particular be the thing for which they are called to pay? Why not provide shoe-leather or blankets, and let the poor have the benefit that assuredly would come to many of them from having a direct interest in their children's education? But the whole idea of the rich being bound to contribute to the maintenance of the poor is a vicious one. If such an obligation, properly enforcible by law, exists, then —let us not hesitate to say it—there must be something rotten in our economics; and we can not too soon apply ourselves to finding out what that is, instead of dealing in weak and ineffectual palliatives.

But, we are told, the public-school system educates the people more rapidly than private education could possibly do—educates a greater number in a given time. Does that settle the question? Does the quality of education, do the moral influences accompanying it, count for nothing? Whether would it be better to give five hundred an education destitute of moralizing and idealizing influences, or three hundred an education penetrated by those influences, trusting to the action of the smaller number to promote social order and harmony? We ask these questions not as advancing assumptions, but merely to show that all is not said when it is alleged that the state can educate more rapidly than private enterprise. If private enterprise and family effort can educate *better* than the state—better on the whole, taking both intellectual and moral development into account, and also the reaction on the elder generation—the higher value of the work may more than atone for its narrower range.

It is a singular thing that, in spite of his strong faith in state education, our correspondent does not seem to believe that any extension or continuance of it would have the effect of making the people at large so intelligent and self-helpful that, in the future, they would be willing and able to look after the business of education for themselves. He seems to look forward to the perpetuity of the system under which the "wealthy tax-payers" provide funds for the education of the children of the poor; at least he drops no hint that the system is ever to cease. Now, supposing we were to address "the poor" in these words: "Well, good people, we are educating your children for you gratis or nearly so, because we don't imagine you have either the ability or the inclination to educate them without our help. At the same time, please to understand that we don't expect, by any education we may give your children, to make them self-helping when they come to have children of their own. A few of them, of course, may rise, while others, more advantageously situated at present than they, and getting the same education, will fall; but the bulk of them will remain as you are to day, unable to educate their children without the benevolent help of the rich. But don't be afraid for your posterity; the rich will help, as usual. There are no classes in this country." How would all that fall on the ears of the poor? Would it be extraordinary if some one on their behalf were to reply: "If we or our children are not to be educated *out of* our poverty—a poverty so deep as to draw down upon us your insulting patronage—we see but little good in it. Better not to sharpen by knowledge the edge of our misery!"

Let us ask a question. As education spreads in this country, are social distinctions becoming less marked? Are inequalities of fortune becoming less striking, not to say portentous? Our correspondent dreads the spirit of socialism and anarchism, and thinks it may grow if the state does not push popular education vigorously. But the state has been pushing popular education as vigorously as it knew how; and, precisely when our educational status, so far as figures can show, is at its best, do socialism and anarchism, in forms unknown to an earlier generation, raise their misshapen and scowling heads. Might not this have something to do with the *quality* of the education imparted? Might it not have something to do with the withdrawal from the poor of one of the best of all moral influences, that which comes from a direct interest in the education of their own children? Our correspondent wants to have political economy taught in the schools so kindly provided by the rich for the poor. Whose political economy — Marx's or Mill's? Henry George's or President Walker's? It is precisely because they know that the rich not only provide, but in a large measure control, public education, that the poor have such an aversion to all the more orthodox forms of political economy. They want no official doctrines on *that* subject.

No, the more the matter is looked into, the less reason (we believe) there will be found to congratulate ourselves on the overthrow by the state of the old system under which parents planned and contrived and economized in order to get their children taught the rudiments of knowledge. Private education, it is true, has not been entirely destroyed, for well-to-do parents—those who so generously provide public schools for the children of the poor—often prefer private schools for their own children; but it has been destroyed precisely where it used to do most good, namely, among the poor. It may be "revolutionary," but we confess we should like to see the "*laissez-aller*," the "go-as-you-please," if it must be called so, of private enterprise—backed as no doubt it would be by the full force of the modern pulpit—applied to the business of education, without the least help or interference from the political machine, and without any legally enforced contributions from "wealthy tax-payers." Education would then rest on a natural basis, and would have a force and a tone that now it almost wholly lacks. Instead of tending to build up social distinctions, the change would have a directly opposite effect by cultivating among even the poorest a manly self-respect. The intellectual and moral effort which it would impose upon society at large would be in itself an educative influence of the first importance, and would probably go far to arrest a growing vice of the age—a tendency to frivolity. It is not by taking away objects of thought and care from the poor that we are to create a stable society; it is by giving them worthy objects of thought and care. Lastly, by leaving education to be provided for by the direct contributions of the beneficiaries, we should probably raise the general level of wages for the poorer classes, seeing that this is governed more or less in all countries by the general standard of living. At present the general standard of living among the poor does *not* include provision for education; but does any one who understands anything of economic laws imagine that wages have not adapted themselves to that condition? It appears, therefore, that what the rich give with one hand they take away with the other, and, as a reward for their generosity, are allowed to control in considerable measure the education of the poor. Who gains by that arrangement?

We are glad our correspondent has given us the opportunity of making these remarks. As he is evidently a man of much intelligence, we commend the whole matter anew to his consideration; and, in connection therewith, would urge him to read what Herbert Spencer has written on the subject in the fifteenth chapter of his "Study of Sociology."

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### *THE NEXT MEETING OF THE AMERICAN ASSOCIATION.*

New York, we understand, is this year to have the honor of entertaining the American Association for the Advancement of Science, the thirty-sixth annual meeting having been appointed to be held in this city, for the second Wednesday in August. There are many reasons why our people should give the Association a hospitable and hearty welcome, and spare neither effort nor money to make its visit pleasant and its meeting a success. While this is the largest city on the continent, it enjoys the unenviable distinction of being one of the very few that have never entertained the Association, although that organization is now nearly fifty years old. This is in strange contrast with the well-known liberality and intelligence of our citizens, who have been unstinted in their hospitality to numerous other bodies, with certainly no greater claims to attention; and the omission is made all the more conspicuous by the fact that several towns, not one tenth the size of New York, have already had the Association two or three times. There is, moreover, no community on this side of the Atlantic which is under a larger indebtedness to Science than this one. By virtue of our position we enjoy, far more than any other city, the fruits of the immensely extended commerce of the country, and of the enormous development of its manufacturing and productive interests, all of which have been carried to their present high state of efficiency by the applications of Science. Our close relations and rapid intercourse with foreign nations, the constant interchange of objects of use, art, and thought, involving incessant improvement in all departments of human activity, have been fostered and perfected, either directly or indirectly, through the investigations and discoveries of the workingmen of this and kindred associations; and all the results thus achieved, whatever their form, pay tribute, in one way or another, to the prosperity of the metropolis. Then we have a right to count upon the social and educational advantages of the presence of the Association among us. By its very character it must elevate the aspirations and tastes of the people among whom it meets, in a way that, though the effect is diminished as the circle extends, is nevertheless very widely felt. Those charged with the care of our educational interests can not fail to be helped by its coming. Above all things, they need the spirit of free and independent inquiry encouraged by its meetings, and a little of which, applied to existing educational methods, could not fail to result in marked improvement. That we have something to learn in this respect, and that these visiting Associations may be able to give us material aid, was shown by the incident of the School Industrial Fair, held under the auspices of the "Industrial Educational Association of New York" in this city last year. Many schools outside of New York were represented by exhibits showing the skill of pupils in the useful and ornamental arts, and reflecting great credit on the management of those schools. Our city, with its boasted "system," was wholly unrepresented. But a direct result of the exhibition was to wake up the school authorities, and next time they are not likely to be found so far behind their country *confrères*.

It is to be regretted that the appointment of the meeting was so long delayed. Even a full year's notice is not always enough; indeed, in this respect, the example of the British Association, which fixes its place of meeting two years in advance, is to be commended. But while the time is short for the preparations necessary to make the reception one that shall be wholly worthy this great city, enthusiasm issuing in prompt and energetic action may do much to compensate for this; and it is clearly due to our self-respect, and the reputation we have for liberality abroad, that we set to work with a determination to make the meeting a notably successful one in the history of the Association.

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## LITERARY NOTICES.

Outlines of Classification and Special Morphology of Plants. By Dr. K. Goebel, Professor in the University of Rostock. A new edition of Sachs's Text-Book of Botany. Book II. Authorized English translation. By Henry E. F. Garnsey, M.A. Revised by Isaac Bayley Balfour, M. A., M. D., F. R. S., Sherardon Professor of Botany in the University of Oxford. With 407 Woodcuts. New York: Macmillan & Co. 1887. Pp. 500. Price, $5.25.

As stated above, this work is a new edition of Part II of Professor Sachs's "Morphological and Physiological Botany." It was prepared at the desire of Professor Sachs because of the rapid growth of discovery in this field since the publication of his work in 1873. Although the researches of Professor Sachs were largely confined to the lower groups of the vegetable kingdom, especially to the vascular cryptogams, and were here first given to the world, in Part II of his text-book. Of its 850 pages 250 sufficed for the treatment of morphology and classification. Such, however, has been the activity of investigators in this field in the last few years, that Professor Goebel has taken 500 pages for its present treatment. Of these 500 pages three fourths of the space is given to that section of the vegetable world popularly known as flowerless plants; for it is here, where so much was uncertain, that research has been most active.

Professor Goebel is himself an original investigator in botany, and the present volume contains not only the changes required by the recent literature of the science, but the results of his own research. Under the circumstances, it will be no matter of surprise that the provisional classification of the past has given place to considerable and important changes. Among these it may be mentioned in the first place, that the division of the vegetable kingdom into cryptogams and phanerogams is out of date. The discovery of the true relations between phanerogams (gymnosperms and angiosperms) and the vascular cryptogams has revealed that the gymnosperms, mosses, and vascular cryptogams form a natural group aptly described as *Archægonatæ*. "It would be thoroughly in accordance with our present knowledge to divide the forms of the vegetable kingdom into thallophytes, Archægonatæ, and angiosperms." For the sake of simplicity of statement, however, the gymnosperms and angiosperms still form one division called seed-plants (spermaphytes). The vegetable kingdom is divided into four groups: Thallophytes, briophytes (mosses), vascular cryptogams, and seed-plants. In classifying the lowest group, or thallophytes, it is now established that lichens do not form a special class distinct from algæ and fungi, but must be ranked with fungi. In consequence of the present transitional character of botanical terminology, Professor Goebel has found it difficult to explain the relations of the different groups to each other, and has been obliged to modify the terminology of previous editions. But he has given a very full "Explanation of Terms" at the end of the volume. A prominent feature of the book is an attempt to make use of a consistent terminology based upon homology; and Professor Goebel expresses the hope that the work of improvement will continue until "we shall no longer call the same object in one place a 'placenta,' in another a 'receptacle' or a 'columella,' or use the term 'frons' for the thallus of a Marchantia or a Pellia, or apply the term pro-embryo alike to the protonema of the mosses, the prothallium of ferns, and the suspensor of spermaphytes." This volume will be indispensable to teachers who care to give their pupils the latest product of scientific inquiry.

History of the Pacific States of North America. By Hubert Howe Bancroft. Vol. XXVII. British Columbia. San Francisco: The History Company. Pp. 792. Price, $5.

There is little in this book to remind one of the times when "54° 40′ or fight" was the political cry of the day, and of the great excitement which our country suffered over the Oregon question. Yet the subject of the dispute is the precise territory that was involved in that controversy. That the memory of that dispute should have so lapsed in forty years that it should be only incidentally referred to, if at all, in this volume of nearly eight hundred pages, is a silent comment on the changes that may be wrought in a generation, and a sign of the growing civilization of the age. The period covered by this history is from 1792 to 1887. It is divided by the author into six divisions: First, the discoveries, claims, disputations, and diplomacies relative to the ownership and division of the domain, commonly referred to as Nootka affairs. The second epoch began with the coming of the fur-traders by land, and continued until 1849, when colonization and colonial government began on Vancouver Island. The third term, during which the Hudson Bay Company was still everywhere dominant, lasted till 1858, when the gold discovery overturned the existing order of things, and raised the mainland into a colony. The fourth period, during which there were two colonies and two governors, concluded with the union of the island and mainland under one colonial government in 1866. The affairs of the confederated colony constitute the fifth era, terminating in confederation with Canada in 1871. The present may be regarded as the sixth period. At this time, or in 1886, we are informed that British Columbia, on account of the lack of money in circulation, is not adapted to any large immigration of poor families; but for men possessing even a small capital, there are few more profitable investments than a cereal farm or cattle-rancho within its borders. As an agricultural region the mainland is divided into sections by the Coast Range. The interior has a climate of extremes, and the coast a mild and equable temperature, while the southern portion, with its wide, trough-like valleys, requires irrigation during the summer months. Though it contains large tracts of good arable land, the entire province is better adapted for stock-raising than for the production of crops. Vancouver Island contains not more than 300,000 acres of farming-land, of which less than 15,000 acres were under cultivation in 1886. In the Queen Charlotte Islands there are some 15,000 acres of flat and unwooded land, but of this only a few hundred acres are suitable for agriculture. Public lands are vested in the provincial government, and the policy is followed of reserving them, in the main, for actual settlers. The exports in 1884 amounted to $3,099,814 and the imports to $4,142,286. The exports consisted mainly of coal and gold, fish and fish-oils, peltries, hides, and lumber. The population is described by the author as, if not among the richest, among the most contented, hopeful, and thrifty communities of the Pacific coast, and the colony as entitled to claim the distinction of being one of the most progressive regions of British North America.

Shoppell's Modern Houses: An Illustrated Architectural Quarterly. January, 1887. New York: Co-operative Building Plan Association, 191 Broadway. Pp. 72, with Colored Plates. Price, $1, $4 a year.

The design of this publication is to furnish, with views and plans, designs for houses, etc., in number, from which intending builders may select such as suit them or nearly suit them. Working plans, specifications, etc., will be furnished on application, with plans of such alterations as may be desired, at fixed rates. Estimates of cost are based upon actual cost of structures, such as will be secured by buying the materials and having the labor performed by days' work. The Association represents that within six years eight thousand houses have been built from its plans. The present number of "Modern Houses" contains forty-nine designs for houses, with plans, descriptions, and costs, from $1,000 to $12,000; designs for a railroad-station, and for stables and carriage-houses; articles on "Axioms and Rules of Color"; "Plumbing and Draining"; "Planting a Large Plot"; "Sea-side Cottage Decoration"; and an installment of Viollet-le-Duc's "Habitations of Man in All Ages," which is in course of regular publication.

The Open Court. A Fortnightly Journal, devoted to the Work of establishing Ethics and Religion upon a Scientific Basis. Edited by B. F. Underwood and Sara A. Underwood. Chicago, Ill. $3 per year, single copies fifteen cents.

The aim of this journal, established through the liberality of Mr. Edward C. Hegeler, is announced to be "to continue the work of 'The Index'—that is, to establish religion on the basis of science; and, in connection therewith, it will present the Monistic philosophy." The new journal starts out under good auspices; it is published in convenient form, its typography is very attractive, and, under the charge of the well-known editor of "The Index," we may reasonably expect a successful career.

The four numbers before us contain articles by William J. Pottor, upon "Society and the Individual"; Professor Thomas Davidson, upon "The Need for Free-Thought Education"; Edmund Montgomery, upon "Monism in Modern Philosophy and the Agnostic Attitude of the Mind"; by Moncure D. Conway, upon "Unitarianism and its Grandchildren" and "Jephthah's Daughter at Honolulu"; and by Anne Olcott Crommelin, upon "Flowers and Poets." There are also an editorial department, correspondence, discussions, and book-notices.

With the aims of "The Open Court" we are in full sympathy. There can be no more worthy nor more important object than that of establishing a scientific basis for ethics and religion. The times are ripe for labor in that direction, and able, well-directed efforts thereto ought to be welcomed and encouraged in every way. We trust "The Open Court" will become a potent influence favoring the reduction to a scientific platform of the principles and precepts of these great departments of human interest.

We do not understaud that the presentation of the "Monistic philosophy" is intended to make the successor of "The Index" an *organ* of any theory of knowledge or being; for, while philosophy is not to be disparaged, it is far better to stand firmly upon science, and thence reach outward and onward to philosophy with much caution. If the prime object of the journal is the scientific study of morals and religion, it is not likely to become conspicuously a vehicle for the expression of speculation, but will, as "The Index" used to do, make the practical work of improving men's lives and promoting the organic growth of society its chief end, quite irrespective of philosophical or metaphysical doctrine.

The Chemistry of the Sun. By J. Norman Lockyer, F. R. S. Illustrated. London: Macmillan & Co. Pp. 457. Price, $4.50.

The general problem of the chemical constitution of the sun's atmosphere, to which the author has given a large share of his attention for many years, is among the newest and freshest, as well as one of the grandest and most fascinating, questions which science has yet attempted to answer. Although astonishing progress has already been made in this field, considering the difficulties encountered, yet the work is so vast that the time of many observers must be devoted to it before it can be said to be more than begun. The first step in the direction of spectrum analysis was taken by Kepler, who, one hundred and fifty years before Newton, observed the decomposition of white light by the prism. Nothing further was done till Newton took up the subject, and by reasoning and experiment greatly enlarged our knowledge of it. Another period of a century and a half elapsed, and then Wollaston discovered that the spectrum of sunlight is divided into several portions by dark lines. In 1814 and the following years the first great advances in spectrum examination were made. Fraunhofer constructed a map of the solar spectrum, on which he marked no less than five hundred and seventy-six dark lines, and these have ever since been known as Fraunhofer lines. His attempts to account for the lines satisfied him that they were not due to any terrestrial cause, but that "they have their origin in the nature of the light of the sun." He introduced the use of the telescope for observing the beam of light after its passage through the prism. He also introduced the method of observing stellar spectra which is still employed, and he investigated the spectra of artificial light-sources. Sir David Brewster discovered that dark lines were produced in the spectrum when nitrous-acid gas was interposed between the prism and the source of light. Many of these lines seemed to him to be identical in position with some of the Fraunhofer lines in the solar spectrum, and he accordingly felt himself justified in announcing the discovery of nitrous-acid gas in the atmosphere of the sun. This was the first chemical touch in solar inquiry. He also stated his belief that all the Fraunhofer lines were due to some absorption at the sun. Foucault then discovered that the bright lines from a colored light had the same places as the dark absorption bands from the same source. In 1852 Professor Stokes first proposed an explanation of this phenomenon, and the same idea was published by Ångström in the following year. The famous discoveries of Kirchhoff and Bunsen began to appear in 1859. Among the earliest of these was that the absorber must be cooler than the radiator. Stokes had suggested that the presence of many terrestrial elements might be detected in the sun's atmosphere by a comparison of the spectra of these elements with the Fraunhofer lines, in the way that sodium had already been detected. Kirchhoff attacked this problem vigorously and obtained abundant results, finding nine terrestrial metals present in the solar atmosphere. Ångström and his collaborator, Thalèn, were occupied with similar inquiries.

About this time Mr. Lockyer's work on solar phenomena began. He applied to the examination of sun-spots and faculæ the device of throwing an image of the sun, or of any desired part of the sun, on the slit of the spectroscope. Up to 1866 it had been possible to examine the solar prominences only during eclipses. In that year Mr. Lockyer devised a method of observation which can be used at other times, making for the observer what have been called "artificial eclipses." It was the illumination of our air that interfered with such observations, and he abolished this interference by using several prisms in the spectroscope, which, by successive dispersions, so greatly enfeebled the continuous spectrum of the light diffused in the air, that the bright lines due to the prominences could be readily seen. Current investigations were being made on the basis of Kirchhoff's hypotheses, that the absorption which produced the Fraunhofer lines took place at some distance above the photosphere, the spots being solar clouds, and that the chemical elements present in the solar atmosphere were identical with some of those existing on the earth, and their spectra were identical. The observations of Mr. Lockyer and his collaborator, Dr. Frankland, soon led them to propose modifications in Kirchhoff's theory, for they showed that the dark lines increased both in width and number as the photosphere was approached. Moreover, the lines in the spectra of the various terrestrial elements were found not to coincide so perfectly with the Fraunhofer lines as had been believed. Certain lines were found in the spectra of two or more substances, and the same substance was found to have more than one spectrum. Difficulties multiplied. The sun had been regarded as a type of what our earth once was, but spectrum analysis apparently showed it to have a chemical constitution widely different from that of the earth's crust. Only one terrestrial substance classed as non-metallic (hydrogen) had been found on the sun, while no trace of elements so common on the earth as oxygen, silicon, and chlorine, could be discovered. It had been noted by Ångström that spectral lines vary their intensities with the temperature. This is the starting-point from which Mr. Lockyer develops his theory of the chemical constitution of the solar atmosphere. When a metallic compound vapor is dissociated by the electric spark, the character of its spectrum changes from channeled and banded to lined. The effect of increasing degrees of heat within the limits known on the earth is to reduce compound bodies to simple ones. Now, on the sun occur temperatures immeasurably greater than we are able to produce on the earth, and it occurred to Mr. Lockyer to ask if iron, for example, were subjected to the heat of the sun, whether it would exhibit the spectrum of iron, or the spectra of some simpler substances—the constituents of iron. Many facts relating to terrestrial, solar, and stellar spectra unite to convince him that in the reversing layer of the sun a high degree of celestial dissociation is at work, which prevents the coming together of the atoms which at all temperatures yet attained on earth compose the metals, metalloids, and compounds. He has applied many and various tests to this theory, but the results of all serve only to confirm his belief. The theory also seems to him to conform satisfactorily to the observed physical phenomena of the sun. Mr. Lockyer has stated his views, and detailed the investigations which led up to them, in a way that will command the attention and respect of scientists, even where he does not produce conviction. Moreover, his work and that of his predecessors has been described in so clear and interesting a style, that the general reader will be able to go through the book with pleasure and profit.

Mineral Physiology and Physiography. A Second Series of Chemical and Geological Essays, with a General Introduction. By Thomas Sterry Hunt, M. A., LL. D. (Cantab ). Boston: Samuel E. Cassino. Pp. 710.

The essays of which this volume is made up have been written in accordance with a predetermined plan that is now accomplished. The first and second are intended to serve as a general introduction, and to show the relations of the natural sciences to each other, and to that complex study known as geology.

The first essay is entitled "Nature in Thought and Language," and gives historical and philosophical reasons for the use of the term physiology in relation to the mineral kingdom. The second embodies a simple scheme for the classification of the natural sciences, by which the sciences of inorganic and those of organic nature are divided into a descriptive and a philosophical group. In writing the six succeeding essays it was the author's design to bring together in a concise form the facts and the reasonings from which are deduced what he regards as the *principia* of geogeny, geognosy, and mineralogy. The chemistry of the atmosphere, and the relations of the earth's aërial envelope both to outer space and to the gases condensed, and the waters precipitated on the surface of the globe, are set forth in the third and fourth essays, as a preliminary to the study of rock-masses. In the next three essays the genesis and the geognostic relations of the various crystalline rocks are considered; and finally the decay of these, which has determined their present surface-outlines, and has given rise to the materials of the uncrystalline sedimentary strata. In the fifth essay, Professor Hunt attempts to show the defects of the several other proposed explanations of the origin of the crystalline rocks, and sets forth his crenitic hypothesis, according to which they have been derived—for the most part indirectly and by aqueous solution—from a single primary plutonic mass. These and other related points are more fully discussed in the sixth essay.

A system of classification for the mineral species composing the earth's crust, which should consider their physical characters in connection with their chemical composition, and the mode of formation of mineral species, has seemed to the author for many years to be a desideratum. What he believes to be a natural classification of the native silicates is included in this volume, and is followed by an outline of the system as applied to all other native minerals. Regarding the silicates as a natural order, Professor Hunt divides them into three sub-orders: those without alumina, which he calls *protosilicates;* those with alumina and containing combined protoxides, *protopersilicates;* and those with alumina, but no protoxides, *persilicates.* These sub-orders are divided each into five tribes, according to distinctions of structure, hardness, and density. Each tribe is made up directly of species. The silicates are included in the same class with the oxidates, titanates, niobates, tantalates, tungstates, molybdates, chromates, vanadates, antimonates, arsenates, phosphates, nitrates, sulphates, borates, carbonates, and oxalates. This class is numbered II; Class I comprises the metallates; Class III, the haloidates; and Class IV, the pyricaustates, or combustible species. The author has in preparation a treatise on mineralogy which will be a complete presentation of this system.

The next essay deals with the geological history of pre-Cambrian rocks, both in North America and in Europe, and is mainly a condensation from the account given in the author's volume on "Azoic Rocks." Intimately connected with this subject is the history of serpentines, which is sketched in the following essay. The various opinions as to the geognostical relations of serpentines which have been held by different writers are shown, and the author's reasons for maintaining their aqueous origin are given. In the concluding essay, the question of the Taconic rocks is discussed at some length. The eleven essays which are collected in this volume are papers which have been presented to American and British learned societies, and have been published in their transactions and in scientific journals. Changes have been made occasionally in revision, but all additions of importance are inclosed in brackets.

Annual Report of the Chief Signal-Officer of the Army for the Year 1885. Washington: Government Printing-Office. Two vols. Pp. 609, 440.

The course of instruction pursued at Fort Meyer has been enlarged and otherwise improved, and now provides for theoretical and practical instruction in the duties required of the Signal Corps in time of war. Lectures by professors of meteorology have been provided for; and a course of instruction in military surveying, field-sketching, and topographical drawing has been added. A text-book of meteorology has been prepared by Professor William Ferrell, and forms the second part of the present report. Professor Cleveland Abbe has in preparation a treatise on the theory of instruments used in meteorology. Translations of papers on temperatures and storms by Ragone and Wild are appended; and translations have been made of important treatises on meteorology; and other translations, giving the most recent and trustworthy results, are in course of execution. The special indications for particular localities have been largely increased. Of the "general indications," from 82·6 to 87·3 per cent monthly were verified during the year; of the Pacific coast indications, from 76·7 to 92·3 per cent; of the cautionary offshore signals, 93·6 per cent for direction, and 85·3 per cent for velocity; of the cold-wave signals, 86·2 per cent. Four hundred and eighty-nine stations were in operation on the 30th of June, 1885.

The Fall of Maximilian's Empire as seen from a United States Gunboat. By Seaton Schroeder, Lieutenant U. S. N. New York: G. P. Putnam's Sons. Pp. 130. Price, $1.

"A letter-book and a log-book," says the author, "are the foundation upon which the fabric of this narrative rests." Lieutenant Schroeder was attached to the United States Steamer Tacony, Commander Roe, which was dispatched to Mexican waters in 1867, "to protect American interests" in those regions while the people were ridding themselves of the French and their Austrian mock-emperor. He was, therefore, more or less a personal observer of the events that occurred from that time till the intruders were finally expelled, and Maximilian was executed; and of all those transactions in which foreign agents could participate. Besides what he saw himself and heard from his intercourse with the officers of the fleets of other nations stationed in the same regions, "a scrutiny of various executive documents, departmental files, and volumes of diplomatic correspondence, has elicited from those musty sources certain interesting matters not presented in any history connected with the closing scenes of Prince Maximilian's short reign in Mexico." The result of the whole is a modest, straightforward narrative which is a contribution to history.

Agriculture in some of its Relations with Chemistry. By F. H. Storer. New York: Charles Scribner's Sons. Two vols. Pp. 529, 509.

This book, the author says, has been written in the interest of persons fond of rural affairs, and of students of agriculture. It makes no special appeal to chemists or to students of chemistry. It is based upon lectures, suggestive rather than encyclopedic, which have been delivered annually by the author at the Bussey Institution during the past sixteen years (1871–1887). These lectures, which have been many times altered and revised, were addressed to small classes of students of two distinct types—viz., young farmers, and sons of farmers, familiar with the manual practice of agricultural operations, who were desirous of studying some of the sciences which bear most immediately upon the art of farming; and city-bred men, often graduates of the academic department of the university, who intended to establish themselves upon farms, or to occupy country-seats, or to become landscape-gardeners. The lectures are upon a considerable range of subjects, which may, perhaps, be only partly covered by such headings as the relations of soil, air, water, and the plant; tillage; manures (including the chemical action of the soil, the special manures in their variety, animal and vegetable refuse, green manuring, vegetable mold, farm-yard manure, composts, night-soil, etc.); rotation of crops; action of fire on soils; irrigation; sewage; the disposing of farms; various crops; and pastures. To such inspection as we have been able to give them, the practical value of the lectures appears high as compared with most other works of the class.

A quarterly journal is to be started at an early date, to be entitled the "American Journal of Psychology," and to be under the editorial control of G. Stanley Hall, Ph. D., of Johns Hopkins University. It will attempt to gather up and present, in a compact, accessible form, the results of scientific psychological research which are of value and are now widely scattered, and even have sometimes to be looked for in other departments of science. It will contain original contributions of a scientific character, recording experiments and studies in all branches of the subject; papers of importance from other journals; and digests and reviews, in which attempts will be made to give a conspectus of the more important psychological literature of the three months preceding publication. Each number will contain from sixty to one hundred pages, and the subscription price will be $3 a year.

Talks with Socrates about Life. Translations from the Gorgias and the Republic of Plato. New York: Charles Scribner's Sons. Pp. 173. Price, $1.

The character of the dialogues from which these selections are taken is too well known to require any special notice here. The text is preceded by an introductory analysis of the purpose of the "Talks" and accounts of the interlocutors, and is followed by annotations. The conversation is described as relating to the perpetual controversy between the material and the ideal, and concerning the real original existence of the moral law.

United States Commission of Fish and Fisheries. Report of the Commissioner for 1884. Washington: Government Printing-Office. Pp. 1204.

Besides its usual routine work, the commission directed a number of special undertakings, all of which are fully described in the report and the accompanying papers. Among them were the prosecution of the work on the pier, buildings, etc., at Wood's Holl; the construction of oyster-ponds at Wood's Holl and St. Jerome, and the investigation of the oyster-beds of Chesapeake Bay; the trip of the Albatross to the Caribbean Sea; the investigation of the Florida shad-fisheries, and the examination of the oyster-beds in Long Island Sound; the investigation of the fish-epidemic in Wisconsin lakes; the collection of specimens of cetaceans; the occupation of stations at Fort Washington on the Potomac, and at Weldon, North Carolina; efforts to hatch the codfish at Wood's Holl; the planting of lobsters in Chesapeake Bay; and the importation of the blue carp and of the European trout. The Appendix, which forms most of the volume, and is devoted to special papers and reports in full, contains the reports of steamers (the Albatross and Fish-Hawk) and stations; fifteen papers of a general or statistical character on the fisheries of this country and Northern Europe; five papers on fish-culture, including a long one, by Carl Nicklas, on pond-culture; a series of statements from persons immediately engaged on some results of carp-culture in the United States; and papers on oyster-culture; five papers detailing scientific investigation; a statement by G. Brown Goode, of the status of the commission in 1884, etc.

Recent Advances in Meteorology. By William Ferrel. Washington: Government Printing-Office. Pp. 440.

This hand-book constitutes the second volume of the report of the Signal Service for 1885. It aims to present the principles of meteorological science and their applications as they have been developed up to this time, for the use of students, and especially for the purposes of a text-book to be used in the Signal-Service school of instruction at Fort Meyer, Virginia. The effort has been made to select, from the material on hand, that which bears most usefully upon practical meteorology. The mass of matter was, however, found to be too large to be compressed into a volume of the size this was intended to be, and selection was necessary. Plain clews are, nevertheless, given to all facts and observations not directly discussed in the book, by references to the works and papers in which they are treated of. Many researches and problems are subjected to mathematical treatment; and an important feature of the work is found in the formulæ and tables which are so frequently needed in meteorological computations and discussions of observations, with examples for their application.

## PUBLICATIONS RECEIVED.

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Report of the Alabama Weather Service. Auburn, Ala. Pp. 7.

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Report of the Massachusetts Agricultural Experiment Station. Boston: Wright & Potter Printing Company. Pp. 136.

Putnam, Samuel P. The New God. New York: Truth-Seeker Company. Pp. 34.

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Stowell, T. B., Ph. D. The Facial Nerve of the Domestic Cat. Pp. 19.

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## POPULAR MISCELLANY.

**A Fraudulent Benefaction.**—The tricks of fraudulent schemers are endless, and are marked by the greatest craft, so that even the most wary are sometimes taken in by them. There came to us some months ago what purported to be the honest proceedings of a national society—"The Fruit and Vegetable Growers' Association of the United States." Among the "Transactions" was the approval of an offer, by the inventor, of freedom to make and use a fruit-evaporator, said to be superior to any ever before devised. Trusting to the honest appearance of the item, we noticed it as a public good, and the notice appeared in our last number. We are now informed, by Mr. Oscar C. Gibbs, editor of the "Farmers' Review," Chicago, in a note, for which we thank him, that the whole affair, including the society and the evaporator, is fraudulent. He writes:

*D. Appleton & Co.:*

Gentlemen: In your "Monthly" for April, on page 862, I notice an article entitled "A Fruit-Evaporator for the Public," purporting to present the proceedings of a meeting held at Columbus, Ohio (date not given), at which was offered to the "Fruit and Vegetable

Growers' Association" the plans of a fruit-evaporator, on condition that they should be published and furnished free to all applicants. This is simply a fraudulent scheme to secure free advertising, and of which "The Popular Science Monthly" has fallen a victim, unless the matter referred to in its columns was paid matter.* The scheme was tried on the agricultural press of the country last year, but with only partial success, as the fraud was soon detected and exposed. They now seem to have *tackled* the periodicals. I inclose a page from the "Farmers' Review" of July 28, 1886, which fully exposes the whole fraud. For any further information which you may desire, I refer you to the "Country Gentleman," "Rural New-Yorker," "Ohio Farmer," or any other reputable agricultural journal. Trusting that the next issue will contain such reference to this pretended association as shall counteract any advantage the parties might otherwise derive from the publication in the April issue, and will also put other periodicals on their guard,

I remain, very truly, yours,
O. C. Gibbs,
Editor "Farmers' Review."

Chicago, *March* 29, 1887.

It appears, from papers which Mr. Gibbs sends with his letter, that the object of the recommendation is to induce parties to write to the address given for the plans and drawings promised, when they are informed that another and still better evaporator has been put upon the market, which will be furnished them at a price less than the cost of making the "Arnold Evaporator." The pretended society consists of persons interested in the sale of the new evaporator; and the names of persons of known repute, which are enrolled in its list of members, appear to have been borrowed without the owners' consent. So, if any of our friends have intended to inquire about the "Arnold Evaporator" on the strength of our notice, we only have to say to them, "Don't." To those who may already have been misled by our item we offer our apologies.

**The New York Skin and Cancer Hospital.**—The New York Skin and Cancer Hospital was incorporated in November, 1882, and now has a city hospital building in East Thirty-fourth Street, at which more than four thousand cases have been treated by a staff of physicians of recognized competence, and a country branch of cottage pavilions at Fordham Heights, near High Bridge; the two properties being valued at about $80,000. The pavilions of the country branch are projected in recognition of the fact which has been abundantly verified in army practice, that such structures, light, airy, and admitting only a small number of patients at a time, are free from the objections which attach to the solid buildings of city hospitals with their crowds of patients occupying the same quarters year after year. They are much more easily and for a longer time kept free from the infectious qualities likely to attach to a permanent hospital, and the patient is relatively secure from the peril from poisonous influences which he is sure to incur in a city hospital. Being slight and cheap, they can be removed if they finally become infected, and their places supplied by new, clean, and entirely wholesome cottages. The estate at Fordham comprises sixteen acres of land in an elevated situation that commands fine views of the Hudson River and Long Island Sound. It will be occupied with cottages as they are needed, and the means are supplied for building them. Two have been built, and are in use, and four others are under way. The experiences of the past year, we learn from the recently published fourth annual report, have already indicated the wisdom of the new undertaking. "The favorable effects of fresh air, sunshine, quiet, and isolation upon the cancer-patients is shown in the prolongation of life, and in the comfort and helpful care it is possible to administer." Upon the record of what they have accomplished, the managers of the institution invite gifts for building other cottages, to be named by the giver, costing from $2,000 to $5,000 each; and endowments for beds, of $3,000 during the life of the donor, and $5,000 in perpetuity. The total cost of hospital accommodations for one hundred patients on this plan of building is estimated at $50,000, which, with $50,000 paid for the property, will make the price $1,000 a bed—a very small sum, compared with the cost in some other hospitals. The managers are aided in the care of patients by the Ladies' Auxiliary Board, by whose exer-

* Nothing of this kind has ever appeared in "The Popular Science Monthly" outside of the regular and avowed advertising pages, under any guise.—*Editor.*

tions a sufficient fund has so far been kept in hand to provide for the treatment of every patient who has made application; so that none have been turned away on account of inability to pay the cost of treatment. While it is not intended to make the institution a charity, it is desired to keep this feature up. A prize fund has been started to encourage the research for new and effective remedies and methods of treatment for cancer.

**The American Society of Naturalists.**—The meeting of the Society of Naturalists, which is composed of persons who regularly devote a considerable portion of their time to the advancement of natural history, was held in Philadelphia in the latter part of December, 1886. A prominent place is given in the proceedings of the society to the discussion of questions relative to methods of investigation and of instruction. At the present meeting the discussion on methods in teaching was led by Professors H. S. Williams and Davis, of Harvard College, on geology and geological investigation; Farlow, on botany; H. N. Martin, on collegiate teaching of biology; and Whitman, on the proper position of biological investigation in the university. It is contemplated to discuss the subject of science in the schools at next year's meeting.

**Why English Trade is declining.**—The latest English "Blue-Book" exposes the fact that English trade is falling behind in most countries, while German commercial interests are gaining the ascendant. The reasons for the change are somewhat complicated, but the principal ones may be summed up in the assertion that English merchants have lapsed into a kind of indifference about pleasing and accommodating their customers, while the Germans are taking great pains to ascertain and meet their wants. The reasons assigned for the superior vigor of German trade in Italy are a "higher standard of technical education, greater activity in the employment of commercial travelers speaking Italian, greater attention paid to the wants of the Italian market, and greater facilities for delivery and for payment." In Bulgaria, "some Jew from Vienna comes every week offering something wanted." The remark applies to several countries. "Ask an English manufacturer to alter the shape of an article to meet the requirements of foreign markets, . . . he generally refuses. The German manufacturer, on the other hand, has no prejudices; if he find that an article of a certain shape commands a ready sale in any particular country, he makes it, however foreign it may be to his own tastes and wants." So it is in Greece, Roumania, Servia, Turkey, Spain, and South America. The lesson is drawn from these facts by the "Spectator" that the English manufacturer must display more intelligence, more adaptiveness, more energy, more sympathy, if he is to hold his own against the increasing rivalry of the highly educated, active, and expanding German. His commercial education must be improved. Boys must be taught the modern languages, and be given a speaking as well as a grammatical acquaintance with the tongues of the peoples with whom they are to stand in commercial relations. But these and other branches of commercial importance still hold only a subordinate place in English secondary schools, while men of commerce and manufacture are trained almost entirely in subjects rather suitable for the professions.

**Sewerage and Typhoid Fever.**—The Baltimore "American" some time ago questioned the value of a system of sewerage in promoting the health of a city, and cited, in justification of its doubt, the case of Baltimore, a healthy city without a system, as opposed to Brooklyn and Boston, where the systems of sewerage are extensive, and yet diphtheria and scarlet fever and other like diseases are more prevalent than in Baltimore. The London "Sanitary World" answers these doubts by citations from the report of Mr. Erwin F. Smith to the Michigan Sanitary Convention on "The Influence of Sewerage and Water-Supply on the Death-Rate in Cities." This paper shows, almost decisively, that the introduction of sewerage and water-supply jointly has had a marked influence in reducing the mortality from typhoid fever, at least. The difficult point is to ascertain the influence of the sewerage alone. The introduction of a pure water-supply is unquestionably an important element in producing this result. But whether the chance of air-pollution is greater from sewers or from cesspools is not so easy to determine. There are a few records, however, which will help to clear this point. In Berlin, the distribution of cases of fever has been found to be one to each 9·3 unsewered, one to each 49·3 sewered houses. In Dantzic the mortality from typhoid fever dropped to less than one fourth the old rate after the introduction of the sewers in 1872, and has been still lower during the last five years. In Cincinnati the water-supply is abundant, but the sewerage is imperfect, and the death-rate from typhoid is increasing. The city of Mexico enjoys a water-supply of forty-four gallons a day to each person, but there are no sewers, and the fever mortality is very high.

**Various Kinds of Rivers.**—M. Wocikoff, the Russian meteorologist, considering rivers from a climatological point of view and with regard to their sources of supply, makes several types or classes of them. The first are those which derive their waters from the melting of snows in plains or regions of not more than three thousand feet elevation; such rivers exist only in the extreme north. Next are rivers fed by the melting of snows in the mountains. Instances are the Amou and Syr Darias, the Tarim, and the upper Indus. In their lower course these rivers traverse regions where it seldom rains, or rains only in winter. High waters occur in them at fixed periods, and the maximum height depends on the quantity of snow on the mountains. They are utilized in the plains of their lower course, where cultivation would not otherwise be possible, in vast systems of irrigation. A third class of rivers depend on rains, usually tropical and monsoon rains, and reach their maximum in the hot season. They are best represented by the Congo and the Orinoco, in whose valleys snow never falls. They are low in winter, or the dry season, and reach their maximum stage in summer, when immense quantities of rain fall into them. Some of the tropical rivers, like the Amazon, are partly fed by melting snows, but in very small quantity; for the snow exists only on mountain-tops above twelve thousand feet in height. To this third class belong also the Nile, the Ganges, and Brahmapootra, and the great rivers of China. That the rivers of China, Mantchooria, and the Amoor region possess the common feature with tropical rivers of having their freshets in summer is a testimony to the prevalence of the monsoons in their regions of supply. To a class that receive most of their waters from rains, but are swollen periodically by the melting of the snows, belong most of the rivers of Western and Northern Siberia, European Russia, Scandinavia, Eastern Germany, and the Northeastern United States. The southern hemisphere has no such rivers. A fifth class of rivers depend on rain-water, are of constant flow, and are highest in the cold season, without being subject to sudden freshets. They are found in the eastern part of the United States, in New Zealand, and in South America beyond latitude 40°. Other rivers receiving their waters from rain, and being highest in the cold season, are marked by great differences between high and low water. They predominate in Southern Europe, and are exemplified by the Po and Tiber, and by some rivers in the United States. Other types may be constituted of rivers which become dried up or lost in their course, and of those which exist as streams for only a part of the year. They are found in desert regions.

**Improvement of our Climate.**—Mr. John C. Goodridge, Jr., has suggested a project for modifying the climate of the Atlantic coast by closing the Strait of Belle Isle, and advances the theory that this scheme is feasible as a problem in physical geography capable of an engineering solution. He argues that it is shown by charts that the great body of the "cold wall" comes to us through that strait. Newfoundland deflects the remainder of the Arctic current to the southeast. Here, pressing against the Gulf Stream, it veers southward in the form of a loop, and finally, running under it, goes on toward the equator. That part of the Gulf Stream that passes our shores has a course directly north and a little west, is deflected slightly toward the east by the coasts of South and of North Carolina, and thence turns more to the north again, when it is deflected by the cold current returning from the pole. When this cold current is of least strength, as in August and September, the Gulf Stream comes within ten miles of Barnegat; at other times it is distant one hundred and twenty miles, changing with the amount of the cold current and of the wind. If we had not the cold wall between our shores and the Gulf Stream, it is fair to presume that we should have a less stormy coast, as the juxtaposition of these two currents with their difference in temperature must from that circumstance tend to an unstable condition of atmospheric equilibrium. Our cold northwest winds would then sweep to the north of us, and become westerly and southwesterly winds.

**Production of Coke in the United States.**—It is shown by the report of Mr. Joseph D. Weeks, of Pittsburg, to the United States Geological Survey, covering the period from 1880 to 1885, inclusive, that Pennsylvania stands first in the rank of coke-producing States, Alabama second, West Virginia third, and Tennessee fourth. The largest coke-producing locality in the country is the Connellsville region of Pennsylvania, in which were made 3,096,012 of the 5,106,696 tons, or 60·6 per cent of the coke produced in the United States in 1885. The second largest producing district is what is called the Irwin-Latrobe district, which lies along the Pennsylvania Railroad, from Larimer to Blairsville, and is, in part, the northerly extension of the Connellsville coking-field. The number of establishments has slightly decreased, but the number of ovens was increased from 1884 to 1885 by 2·8 per cent, and was in the latter year 20,116. While the production of 1885 increased over that of 1884, it was not as great as in 1883. There has been no increase in the value per ton of coke for three years.

**How Harbor-Channels may be kept clear.**—Professor Lewis M. Haupt addressed the Section of Mechanical Science and Engineering of the American Association on "River and Harbor Improvements, with Special Reference to the New York Entrance." He maintained that large and weighty structures intended to regulate currents, which rest or depend upon sandy or alluvial bottoms, violate the fundamental requirements that they shall not oppose the ingress of the tide or injuriously modify the currents. Dikes and jetties also are below the plane of action of waves of translation; while dependent upon their mass they are not entirely coherent; and they are wasteful, and result in serious modifications in the regimen of rivers and harbors. He suggested as a preferable system, one consisting of deflectors intended to be attached to buoys or floats, anchored to heavy moorings, and guyed in place on the ebb side by wire cables or chains. This system is composed of units or parts readily assembled, which occupy little space, yet control the currents, and deflect them upon the obstruction to be removed. By it the prism of water passing through a given section can be increased indefinitely, while the aperture of discharge may be diminished, thus producing any required velocity. Stress was laid upon the importance of applying a method which should be limited to the removal of so much of the crest of the bar as would secure the requisite channel, and no more.

**The Amazons Valley.**—Mr. James W. Wells, in an address before the Royal Geographical Society, on "The Physical Geography of Brazil," divides the rivers of that country into three great systems: the basin of the Amazons, including also the Tocantins and Araguaya; the basin of the Plate River, and the many distinct and separate rivers draining into the Atlantic. The Amazons basin is divided into the bottle-shaped, low-lying forest of the upper valley, 1,300 miles long by 800 miles broad, and its circumscribing elevated table-lands, which, near Obidos and Santarem, approach close to the banks of the main river, and constitute the neck of the bottle-shaped area. Throughout the length of this river, east and west of Obidos, the adjoining land is so low and flat that we have in many cases rather a series of more or less parallel streams than one great, clearly defined stream. It is possible to go in a canoe up the whole of the valley in these lateral channels, and also to pass through the deep forest by natural canals, from one tributary to another, without once entering the main river. It is a singular feature of the Amazons Valley, considering the mass of the water and its equatorial situation, that it is so healthy as it really is. Some of the tributaries of the Amazon are very insalubrious, and life anywhere in them, in any condition, is made miserable by insect pests; yet Mr. Wells has never met any one, who has had an experience of life on the Amazons, who has not become passionately fond of it. "The glorious vegetation, the life free from conventionalities, and the brilliant sunlight and warmth, tempered by fresh breezes, contain some of the elements of making a paradise," and numerous lines of river-steamers afford means of convenient communication. The vegetation of this great valley is essentially different from that of the other two riverine systems. The rich, low-lying lands, subject to annual inundations, frequent rains all the year, and the continual heat, produce a vast wealth of dense tropical verdure, and a forest area greater than can be found in any other part of the globe, intersected by thousands of miles of immense navigable streams, give the region a unique character. Among the valuable vegetable productions, the India-rubber tree figures pre-eminently. It exists in such vast numbers, and the collection of the juice is so very lucrative, that it has attracted to even the most remote rivers thousands of adventurous Brazilians from the adjoining provinces, and it is doing for the Amazons what gold did for Australia and California.

**The Microbe of Malaria.**—Dr. George M. Sternberg has communicated to the Scientific Association of Johns Hopkins University an account of the confirmation, by his own observation, of Laveran's discovery of the germ, or micro-organism, of malaria. Laveran found this microbe in the shape of an amœboid parasite, in the blood of patients suffering from fever; and also observed that the germs disappeared from the blood when quinine was administered in effective doses. His observations were confirmed by Richard, in 1882, and by Marchiafara and Celli from their researches in the Santo Spirito Hospital of Rome. During a recent visit to Rome, Dr. Sternberg accompanied these gentlemen to the Santo Spirito Hospital, where a most satisfactory demonstration was made to him of the presence and amœboid movements of the parasite, in blood drawn from the finger of a patient in the first stage of a malarial paroxysm. Marchiafara and Celli have induced types of intermittent fever, in previously healthy persons, by injecting into the circulation a small quantity of blood drawn from a malarial patient during his fever. The presence of the parasite in the injected blood was demonstrated, and it was found again in the blood of the persons subjected to the experiment during the induced intermittent paroxysms. These paroxysms were arrested, and the parasite disappeared from the blood when quinine was administered.

**Systematic Observations of the Aurora Borealis.**—No country is more favorably situated for the systematic observation of the phenomena of terrestrial magnetism and the aurora borealis than Norway. Extending from the fifty-eighth to the seventy-first degree of latitude, it reaches farther north than any other inhabited land, and lies nearer to the center of magnetic disturbances than any other state of Europe. The maximum zone of the northern lights hangs over the northern and northwestern part of the land. The northern and southern districts are connected by numerous telegraph lines and through the telephone exchanges of Drontheim and Bergen. Sophus Tromholt began to organize a system of investigations in 1878, and from September of that year to April, 1879, he recorded 839 observations of 154 northern lights. His idea met with favor, and the method of concerted observation has spread since that time to Sweden, Denmark, and Finland, England, Greenland, and Iceland. The observations of the winter of 1879–'80 were much more extensive than those of the previous winter, being 1,600 in number of 249 auroras at 357 stations. In the winter of 1880–'81, 5,200 observations were made of about 300 auroras, at 675 stations; and in the winter of 1882–'83, 1,500 persons in the North European countries participated in the work. Notices are now regularly transmitted from fifty Swedish and Norwegian telegraphic stations of all electrical disturbances, with exact minutes of time, direction, etc.; observations that are of the more importance, because not a day passes that something of the kind does not occur somewhere in Norway. Mr. Tromholt intends to publish the year's results of these observations cartographically, with notices of associated meteorological phenomena. For the complete registration of the telegraphic perturbations, he has constructed an apparatus which graphically represents the time of their happening, their strength, and direction, which is connected during the night with a north and south telegraph line 1,400 kilometres long, while during the day telephones are used. This enterprise is assuming an extent which places its effective control beyond the power of one man. Mr. Tromholt therefore proposes that the Government establish an institute at Drontheim to become the central station of the world, to which all observers on land and sea shall transmit their reports.

**Importance of the Plumber's Art.**—A plea for a higher recognition of the plumber has been made by Mr. William Halley in an address before the Ohio State Sanitary Association. Of the various craftsmen who assist in constructing dwellings, there is not one, perhaps, whose position in the light of sanitary science is more important and responsible than his. In days gone by he was considered a mere worker in lead to supply the simple wants of his employer, as ignorant as himself of the physical laws of his occupation; but now his work assumes the dignity of a sanitarian's. Yet there are few vocations in which skillful work is so little appreciated as that of plumbing. People are not interested in the work because it has no reference to ornamentation, and is almost wholly out of sight. A great deal depends on the plumbing. If it is perfect, the house is healthy; if imperfect, an unhealthy habitation is the result. It is easy to see that it is the most important feature of a house, to which may be added all the convenience, beauty, and polish of a palace. But first of all, stamp it with the character of health by sanitary plumbing. Even with the best devices it is impossible to prevent sewer-gas at times. There are many accidents by which plumbing-work will become crippled and allow gas to escape. Hence it is advisable to exercise extreme care about its location and quantity. Unfortunately, for the plumber and for sanitary effect, the architect is too apt to ignore plumbing and give undue attention to other matters which serve better to display his æsthetic conception. House-drainage is made secondary and subservient to convenience and display. At the last moment it is remembered that the house must be drained, and plumbing specifications are made to fill in the cubby-holes. That is why so much plumbing is worse than useless.

**Foliage-Trees in Colors.**—The "Saturday Review," treating of plantations of trees, dwells upon the effects that may be produced by massing those having foliage of various hues. While every garden has its "ribbon-beds" of herbaceous foliage plants, the arrangement of trees to produce similar effects is still an undeveloped art. What can be done in this line, it says, "is well illustrated at Waddeson Manor, Baron Ferdinand de Rothschild's place in Buckinghamshire. Nothing can be more beautiful than the treatment of foliage trees and shrubs in his ground. It is absolute painting, wherein the pigments are represented by golden yews (*Taxus baccata variegata* and *Taxus baccata foliis variegatis*), golden elders, double-yellow gorse, golden broom, purple barberry, purple hazel, copper beech, purple sycamore (which varies from green and gray to purple with every passing breeze), variegated maple introducing a lighter tinge, which is carried on by a mass of sea-buckthorn, whose pale, frosted silver is relieved by the deep, velvety green of a background of Austrian pine. What cannot be done when such colors as these lie ready to hand, not to mention all the 'glaucous' trees, whose leaves are often white, covered with a silky down or powdered over with a fine dust like that on a butterfly's wing? The American maples, and especially the swamp-maple with its autumn glory of foliage, have made the 'Canadian fall' or autumn a season and object of pilgrimage from all parts of the world. The swamp maple . . . has other merits besides that of its autumn gold. In early spring the leafless branches are clothed with clusters of deep-red flowers, the young growing shoots are reddish-brown in color, and the leaves a bright, shining green above and glaucous underneath." The white or silver maple is also named as a tree producing effects nearly similar.

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## NOTES.

Professor Angelo Heilprin has described, in the Academy of Natural Sciences of Philadelphia, a species of cat-fish from Lake Okeechobee, Florida, which differs in several well-marked characters from other described North American species. It is most nearly related to the cat-fish of the lakes, and greatly resembles it. The largest specimen caught was about twenty inches long. The name *Ictalurus Okeechobensis* is proposed for it.

Dr. Daniel Wilson, of University College, Toronto, said in a paper read before the Royal Society of Canada, that he had concluded, after long research and discussion, that left-handedness is due to an exceptional development of the right hemisphere of the brain. Being left-handed himself, he hopes that when he is dead his own brain may be examined for the help it may give in settling this question.

Mr. J. H. Kerry Nichols, who is well acquainted with the ground, supposes that the volcanic outbreak of June, 1886, in New Zealand, was caused by the subsidence of the crust and the sinter accumulated upon it into the vast caverns which had been excavated beneath by the solvent action of the water that brought the deposits to the top. The whole being in a superheated condition and favorable to strong chemical action, a vast explosion was the immediate result.

Dr. Klein recently exhibited to the Royal Society under the microscope, in illustration of a paper on the etiology of scarlet fever, gelatine cultivations of the *Micrococcus scarlatina*, an organism which has been proved to be present in a certain disease of the cow and in human scarlatina.

The programme of the coming exposition at Ekaterinburg, Russia, promises a very interesting representation of the productions and life of Siberia and the Ural. We are informed that the best time to visit the exhibition will be during July and the first half of August. A special committee will attend at the railway-station to receive visitors and give them such information as will make their expenses as light as possible.

Mr. W. A. Carter, in a recent lecture on "Marine and Fresh-Water Fishes," said that fish have the power of influencing one another by sounds and action. He had observed a shoal of carp following the lead of a single one which conducted them to a quantity of food at a considerable distance away. He had also noticed that certain fresh-water fish, such as trout, were subservient to a ruler, which might be seen swimming at the head of his tribe. The same was possibly the case with some marine forms, like the herring and bass.

A new and complete edition of the works of Galileo is to be published, in twenty quarto volumes of five hundred pages each, at the expense of the Italian Government.

The sectional presidents of the Manchester meeting of the British Association, to be held August 31st, will be: Section A, Mathematics and Physics, Sir Robert S. Ball; B, Chemistry, Dr. Edward Schunk; C, Geology, Dr. Henry Woodward; D, Biology, Professor A. Newton; E, Geography, General Sir Charles Warren; F, Economic Science, Dr. Robert Giffen; G, Chemical Science, Professor Osborne Reynolds. The President of the Anthropological Section has not been designated. Professor H. B. Dixon will deliver a public lecture on "The Rate of Explosions in Gases." The lecture to the working-classes will be given by Professor George Forbes.

The stories, once so current, that seeds taken from ancient Egyptian tombs have grown, are believed, if not demonstrably false, to lack the guarantees of truth that tales of the kind should require; and nothing as to the vitality of seeds can be built upon them. But Dr. Lindley tells of raspberries that were raised in the gardens of the Horticultural Society from seed taken from the stomach of a man who was buried in a barrow near the time of the Emperor Hadrian; and Professor Duchartre and others tell of seeds, whose identity is properly vouched for, taken from under the foundations of an old house in Paris, probably from the original soil of the island, and therefore coeval with the city, which germinated and proved to be seeds of *Juncus bufonius*, an indigenous plant of that soil.

In dealing with a cellar in springy ground, the first thing to be done to make it dry, says "The Sanitary Engineer," is to provide some chance for the water to run away before getting into the cellar. This may be done by laying a two-inch tile drain-pipe in a trench dug all around the foundation outside of the walls, and from one foot to two feet below the cellar floor. Put this pipe together without mortar, and cover it with cobble-stones to keep out the dirt and sand. If it is not practicable to lay the drain outside, it may be laid inside of the cellar-walls, directly in the cellar-floor; but the operation of such a drain is less efficient. The back-filling of the cellar-walls should be porous enough to allow the water to go directly into the drain.

Mr. G. Thomann, of the United States Brewers' Association, has published a pamphlet to show that beer is a perfectly wholesome drink. In support of his assertion, he alleges that while brewers drink more beer, and drink it more constantly, than other people, the average death-rate among them is lower by forty per cent than that of corresponding urban populations; that their health is unusually good, with comparative freedom from diseases of the kidneys and liver; and that on the average they live longer and preserve their physical energies better than the average workmen of the United States. Mr. Thomann produces doctors' certificates showing a mean annual death-rate of 7·5 per 1,000 among 960 brewery-workmen, against 12·5 of urban population; and he talks of men drinking an average of ten pints of beer a day.

A new process in manufacturing iron has been tested at Pittsburg and at Southwick, Staffordshire, England, in which the metal undergoes a chemical change that is claimed to greatly improve the quality and test of the iron to whatever class it may belong. The new process is said to facilitate the running of the metal, and also increase its strength.

Mr. Ruskin, in a recent letter, has expressed his opinion of railways in a brief but most energetic manner. He says: "They are to me the loathsomest form of deviltry now extant, animated and deliberate earthquakes, destructive of all wise social habit, or possible natural beauty, carriages of damned souls on the ridges of their own graves!"

A limited edition of the first volume of a series of selected morphological monographs, by members of Johns Hopkins University, is about to be issued from the publication agency of that institution. The series will be under the editorial direction of Professor W. K. Brooks. The coming number will contain three papers by Professor Brooks, and one paper by E. B. Wilson. Only one hundred copies in all of the volume will be issued.

A bulletin of miscellaneous information has been started at the Royal Gardens, Kew, to be published occasionally, and contain notes on economic products and plants to which the attention of the staff of the gardens may have been drawn, or which may have been made the subject of particular study there.

Mr. John Murray, of the Challenger Expedition, recently said, in the Royal Society of Edinburgh, that he questioned whether any country in the world, taking its size into consideration, could show a better record of scientific work or a greater mass of scientific literature than Scotland during the past ten or twenty years.

Medals and prizes are to be given this year, by the Royal Society of New South Wales, for the best communications embodying fruits of original research on the silver-ore deposits of New South Wales; on the origin and mode of occurrence of gold-bearing veins and of the associated minerals; on the influence of the Australian climate in producing modifications of diseases; and on the infusoria peculiar to Australia.

According to a paper read by Mr. John Murray, before the Royal Society of Edinburgh, 2,243 cubic miles of rain fall annually on areas with inland drainage. Such areas extend to 11,486,350 square miles. The land draining directly to the ocean has an area of 44,211,000 square miles, of which 38,829,750 square miles have ten inches or more of rainfall. The mean discharge from this area into the ocean is 6,569 cubic miles annually. The total weight of substances carried by this means to the ocean is more than 5,000,000,000 tons each year.

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## OBITUARY NOTES.

Captain James B. Eads, the distinguished engineer, died of pneumonia at Nassau, New Providence, March 8th. He was widely known as the constructor of several works of great merit. Among them were the first eight ironclad gunboats owned and used by the United States, the bridge over the Mississippi River at St. Louis, and the system of jetties for deepening the channel of the mouth of the Mississippi. He had projected a plan for a marine railway across the Isthmus of Tehuantepec for carrying vessels from one ocean to the other, and was elaborating its details and seeking means for executing it at the time of his death. A sketch of his life and works, revised by himself, with a portrait, was published in "The Popular Science Monthly" for February, 1886.

Dr. Gustav Heinrich Kirchenpauer, first Burgomaster of Hamburg, and an eminent naturalist, is dead.

Dr. Julius Lüttich, astronomer, and Professor Jean Louis Trasenster, both died on the 3d of January, 1887.

Mr. Alexander Borodin, Professor of Chemistry in the Medico-Surgical Academy at St. Petersburg, and an eminent musical composer, died February 27th.

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# ARE RAILROADS PUBLIC ENEMIES?

By APPLETON MORGAN.

(SECOND PAPER.)

SINCE a paper printed in the March "Popular Science Monthly" was in type, the Interstate Commerce bill has become law. This law establishes a Commission, to whose decision is now committed the regulation of the railways as to their relations with the individual shipper. Since the law permits the railway to apply to the Commission for leave to discriminate as to hauls and shippers,* or otherwise to pursue the tenor of which experience has taught the expediency, it need not prevent a final ventilation of the remainder contents of Mr. Hudson's scrap-book against railroads, nor impose upon us the technical discussion hereafter reserved for the Commission itself. Our last paper left over for consideration :

I. Discriminations by long haul and short haul.

II. Stock-watering (which Mr. Hudson, however, prefers to nominate "the fictitious element in railway policy") ; and—

III. "Eminent domain" (that is to say, a modicum of the power of the State, by acceptance of a grant of which a railroad company is understood to accept the burden of certain public obligations).

It should be premised, perhaps, even at the risk of becoming elementary, that one railroad company is not all railroads. Such syllogisms as : 1. A railway corporation which charges more for a long haul than a short haul is a public enemy. 2. The A B and C D Railroad charges more for a long haul than a short haul ; *ergo*, all railroads are public enemies—or, 1. A corporation which "waters" its capital stock is a public enemy. 2. The E F and G H Railroad once "watered" its stock ; *ergo*, all railroads are public enemies—and the like, are

* Section 4.

mere replica of the schoolboy fallacy: Food is necessary to life: Corn is food; *ergo*, corn is necessary to life (in which the undistributed middle is supposed to elude the urchin logician), and are altogether beside adult discussion of economical questions. But let Mr. Hudson's processes be waived while we address ourselves to the material of the charges he pastes—and I assume that he pastes them correctly—in his scrap-book:

I. The Long and Short Haul.—There certainly never arose in practical railway operation a situation wherein a railway company was solicitous to charge less money for doing more work and to pay its own expenses meanwhile. But in practical railway policy a difference between the cost and the value of certain business to the company might, and sometimes does, arise which appeals to the company's instinct of self-preservation too despotically to be disregarded. A railway company, which has for long years acceptably served its local and through patrons, finds itself suddenly paralleled by a rival company, serving all or some of the same localities not only, but prepared as a part of its (the second comer's) investment to undergo the expense of "cutting" rates, and so to supplant the first comer by offering to take business for less than the actual expense of doing it, even though some of the competing points are farther distant from the common terminals of the paralleled line than the actual length of the roads. Under such circumstances, the value of all of its original business it could retain would be clearly of more value to the first company than the then present cost of doing it: and the result would, of course, by every law of human economy or of human nature, be that the first company would either anticipate or respond to the "cut." The effect in either case would be to cheapen tariffs to the shipper—to the people. But Mr. Hudson, at this moment, does not care for the people. Later on he will take up the cudgels for them, but just now he kindly holds a brief for the railroads. He thinks it shameful that deserving and hard-working railroads should be obliged to take long hauls for actually less than they are legally entitled to charge for short hauls—for much smaller distances. Mr. Hudson has no objection, of course, to one of his fellow-countrymen riding from New York to Chicago for five dollars, or shipping live-stock from Toledo to Buffalo at one dollar a car-load during a railway war. (Or, if he should still remember the poor public, it will be not the poor public who ride a thousand miles for five dollars, or at the rate of half a cent a mile, but the poor public who commonly ride one hundred and sixty-seven miles for five dollars, thereby being compelled to either walk or pay the legal mileage of three cents which the company is allowed by law to charge.) But should the railway companies find that carrying passengers from New York to Chicago for five dollars, or cattle from Toledo to Buffalo at one dollar a car-load does not pay—that by making such rates they are robbing—not the public at large, perhaps, but their own stockholders, and depreciating their own securities; and should, since no other offers, the railway companies themselves propose becoming their own reformers, and so evolve the idea of pool commissions whereby each company might yet live and enjoy the franchises the people had given it—when this new aspect presents itself, we say—Mr. Hudson shifts back to his original brief, and finds the railways once again the rampant enemies of his corraled clients—the people. But on taking up his brief our unfortunate Mr. Hudson finds himself once more out of court, confronted with the terrible truth that under the pool the rates have not only been raised but have actually fallen below a legalized minimum, and his occupation and standpoint again departed. A comparison of tariffs before and after the local pool systems existing at the passage of the Interstate Commerce bill of course can not be attempted here. But it will be found to correspond everywhere throughout the country to the following figures taken at random. (Of course the tariffs need not be compared with figures existing at the inception of railroads, or at intervals of ten years since, because everybody knows—who knows anything, or who reflects upon the subject at all—that the history of the railway has been the history of the tariff reductions upon every commodity, every product of human manufacture or yield of Nature):

| HAUL. | Rates before establishment of pool (per 100 lbs.). | Rates after establishment of pool (per 100 lbs.). |
|---|---|---|
| Omaha to Kansas City or Denver, first class........... | $2.40 | $2.10 |
| Omaha to Kansas City or Denver, fourth class.......... | 1.40 | 1.15 |
| Omaha to Salt Lake City, first class.................. | 3.30 | 3.00 |
| Omaha to Salt Lake City, fourth class................ | 3.00 | 1.55 |
| *New York to Pittsburg, fourth class................. | .30 | .20 |
| *New York to Altoona, fourth class.................. | .28 | .17 |

All the above being non-competitive or "short-haul" points (since Kansas City, Denver, and Salt Lake can only be reached from Omaha—or the points Pittsburg or Altoona can only be reached from New York—by land transportation), there was no legal, certainly no natural, reason (according to Mr. Hudson) why the mere technical fact of a pool should have lowered rates. If, as Mr. Hudson asserts, railways are selfish, grasping, lawless monopolies, enemies of the republic and devourers of the people, there was, on the contrary, every reason why, when three or four railways pooled their issues and monopolized all the possible rail connections to that point, rates should be as high as, if not higher than before. Certainly there is no reason, legal or natural, why, to a point like Altoona, among the mountains, to which but a single through line has had the courage or the charter to climb (and that one, according to Mr. Hudson, one of the most grasping of all his category of grasping monopolies), freights should be lower after the organization

* I take these last two quotations from Mr. E. P. Alexander's "Railway Practice; its Principles and Suggested Reforms reviewed," New York, 1887.

of a pool than they were before. The explanation appears, however, as the demonstration proceeds and the technical meaning of the terms "long haul" and "short haul" becomes self-evident. Clearly the points we have named become "short hauls" as against (for example) San Francisco, the haul to which is therefore called a "long haul." Now, in establishing rates to San Francisco, certainly it is very apparent that the railroads which have pooled to Salt Lake City or Denver must take a new factor into the account, for San Francisco has a most excellent water communication with the entire world, and is perfectly independent of railways, monopolies or otherwise. In other words, it is Nature and not railroad corporations that have discriminated against Denver and Salt Lake City, and in favor of San Francisco, by making it a commercial fact that (since water is cheaper than land transportation) San Francisco is actually nearer New York than Denver or Salt Lake City. The fact is that—so long as railway rates are regulated by geography—however distorted they may appear to the non-expert, the substitution of arbitrary for geographical rules in framing a tariff would result in rendering them still more distorted and uneven. And if the railways, pooled or unpooled, charge proportionately less rates to San Francisco than to Denver or Altoona or Salt Lake City, the higher power that has ordered it is the irresistible power of Nature. To what lengths of invective and diatribe Mr. Hudson and his kind would proceed, did Nature and geography "pool" with the railways, it is amusing to speculate; but the fact—which oppresses the railway company at present, and imposes upon it the necessity of accommodating its rates to Nature (since Nature will not accommodate herself to the railways)—is that no pool can be made with the ocean, which charges nothing to the sons of men who plow its bosom with their ships, and which is at no expense to keep itself in repair. For, let it be always remembered, in discussing these and like questions, a railroad is not, *per se*, a means of transportation. Such a definition is very far from being definitive by exclusion, as a definition ought to be. A railroad is a prepared and exclusive highway for traffic by means of the motive power of the locomotive engine, and is available only where locomotives can be used. There are still the foot-path, the bridle-path, the wagon-road, the ocean, the river, the canal, with which it must compete. There is still the inclined plane, with which (for the down-grade, certainly) no locomotive even can compete. And so, even were railway companies the terrible affairs, the grasping monopolies, the enemies of the human race, which Mr. Hudson asserts them, they are only so because the human race uses them, if it uses them at all, in preference to other means of transportation. Should Mr. Hudson induce his *clientèle* to discontinue their preference, the fact might be different; but in order to accept Mr. Hudson's conclusion (which, be it remarked again, is not the rule of the Interstate Commerce Law) that railways are public enemies because their tariffs sometimes are greater for the long than the short haul, we must primarily assume the two propositions: first, that the public are not at liberty to use any other means of transportation than the railways; and, second, that there is no such thing as competition. Does Mr. Hudson desire us to accept these propositions, or think that he has established them? What else does he mean by such a paragraph as this (page 40): "While the force of competition causes the railways to accept moderate or even narrow profits on the Western grain-traffic, the absence of that force allows them to collect what, by comparison, are shown to be exorbitant profits on the grain shipped by the farmers of the Eastern or Middle States." As a matter of fact, the figures actually show that it is combination, not competition, which has reduced the rates charged by the enemies of the republic and forced them to "accept moderate or even narrow profits." Surely, Mr. Hudson does not wish us to believe him guilty of catering to the general public by misstatements of fact in cases with which, from the least apparent foothold for grievance, he assumes such fluent familiarity. And yet, what else can we conclude from his retort to Mr. Fink's calm statement before the Senate Committee on Railroads in 1883, to the general effect above stated (viz., that geographical and not arbitrary conditions controlled pool-rates) in which he happens to mention Winona (using that town, as we have used Denver or Salt Lake City above, as an instance of a "short-haul" point)? "Why," says Mr. Hudson (page 161), "the road, if built for Winona, should have stopped at that place and given its exclusive attention to the transportation interests of that town." And, if this could be exceeded in artless incapacity, he meets Mr. Alexander's statement (page 162) that "no railway has ever raised its local charges to meet the loss caused by lowering its through rates," by the following: "When railway rates have been reduced fifty per cent on through traffic within the last ten years, and local rates have virtually remained unchanged, the burden of the local shippers has been practically doubled, no matter what sophistry is used to conceal the fact." Surely, it needs no expert in railway affairs to detect that the "sophistry" just here is not Mr. Alexander's. Lawyers of a certain grade sometimes talk to juries in this vein, but they are shrewd enough to know their jury pretty well before attempting it. An industry that employs seven or eight thousand millions of capital in these United States ought, one would say, to be reasonably suspected of employing brains here and there—certainly ought not rashly to be assumed to neglect the entire remainder of its continental field (to say nothing of the keeping of its own books), in order to concentrate its entire energies upon the commercial destruction of a single village! There has yet to be discovered, I suppose, a human institution in whose workings there was not hardship or inequality somewhere. But Mr. Hudson has only, it seems to him, to select his hardship to demolish the entire railway system—his principle being, not the greatest good to the greatest number, but the least good to the greatest number (or, possibly, the greatest good to the least number), so that the selected village is favored. But what else would this be, again, but a monopoly of commercial privileges; and how soon—did the railway or the railways adopt Mr. Hudson's suggestion and discriminate exclusively in favor of his village—before Mr. Hudson would be on his feet again with an entirely new compilation of grievances, demanding to know why this particular village was selected out of the entire continent to be so pre-eminently favored? Does not even Mr. Hudson begin to catch a glimpse of just how vast, how complicated, and inexhaustible this railway problem really is? But possibly he does not, for he says, You charge this village of B too much. No, we charge everybody according to geographical position; it saves us labor to do so, says Mr. Alexander. Well, anyhow, says Mr. Hudson, you lowered the rate to A, and did not lower the rate to B, and that's the act of a public enemy; and he straightway sits down and inflicts us with a book of 500 pages, of which the argument is (or ought to be, to be consistent) that A is not the public or even the republic, whereas B is both the one and the other. If Mr. Hudson will kindly turn to one of his own pages (in which possibly the mass of excerpta has bewildered him), he will be doubtless surprised to find (page 159) an admission that, astounding as it may seem, on a single trunk-line in a single year, as between the anti-pool rates of 1865 and the pool rates of 1882, a saving to the public, in freights alone, of $318,947,486,261 has been effected. But, having made the admission, he is ready to meet it after his kind. "This is an astonishing instance," he continues, "of giving away what the giver never owned or possessed; the fact is kept out of sight that the business of 1882 is the result of the progressive reduction of rates for many years, and could never have existed but for the reductions." Surely, the readers of "The Popular Science Monthly" have never witnessed quite such a wiping out of the laws of supply and demand as this! Mr. Hudson will have us believe that the people of the United States on the line of the given railroad would not have eaten and drunk, or purchased supplies, worn clothes or slept on beds, and that population itself for seventeen years would have suspended its rules—perhaps the laws of gravitation themselves have ceased—had not this railroad reduced its rates. But let us overlook any possible increase of population or of the wants or luxuries of a given territory in the space of twenty-two years, and consider this particular railway company as all railways. The argument will then remain as follows: Railways are public enemies because they are exorbitant in their charges. But figures show that their charges are constantly decreasing. Never mind that, says Mr. Hudson, if railways reduce their rates they only do so from the selfish motive of getting still more business. Most shippers over a railway would be contented if the railway would only charge them low rates. But Mr. Hudson (who, possibly, is not a shipper over any line) will have none of their reduced rates unless they reduce them from the proper motive. After all, the act is nothing. It is the motive which must govern. And doubtless we could nowhere elicit a more virtuous, certainly nowhere a better specimen than this of Mr. Hudson's public-spirited argument against railroads, from this most exhaustive and most entertaining of scrap-books. "No matter what you do, if your 'eart is only true," says the old song. And so says Mr. Hudson to the railroads of this republic. But let it at least be remembered in their behalf that, even if they did it with selfish motives, the railways were themselves the first to attempt their own reformation. Railroads are and must remain built for the private emolument of their owners, and not for charitable purposes. They were not proof against the temptation of charging more money for a short haul to non-competitive points than for a long haul to competitive points in the struggle to live alongside of paralleling lines which the people themselves have chartered. But, when the pool removed this temptation by making all points non-competitive—although no law, human or divine, compelled them; they did voluntarily resist the temptation to pool at maximum rates—the rates not only fell, but became proportionate to cost of hauling, the competition remaining only as to those "long-haul" points in whose favor Nature has discriminated by establishing water communications. Mr. Hudson has, perhaps, read a great many books. He should not have omitted from among them the late Dr. Lieber's "Civil Liberty and Self-Government" (especially the chapter wherein is treated the principle of the "Freedom of Rivers"). Then, remembering that the United States has not only two ocean coast-lines, but great lakes and a system of navigable rivers more magnificent and more benign than that of any other country, he might possibly have perceived how—in his railway problem—so slight a consideration as our national geography might be at least as important a factor as a handful of selected individual hardships. Mr. Hudson does not relish the rates charged by our railway companies. He suggests no others, but is entirely clear, none the less, that they should be changed somehow. If rates are at present arranged upon a system, let us drop the system and make them arbitrary—according to Mr. Hudson's selection, if he would only agree to abide by it. If your present rates are robbing the people, low as they are—very well, lower them still more, and rob your stockholders. It is evident that Mr. Hudson, for one, is no stockholder. But are not our stockholders parcel of the people? And so the old impossibility of finding standpoint—or rather, the necessity of shifting his point of view with each newspaper-clipping he pastes in his scrap-book—renders Mr. Hudson everywhere specious, inconsistent and absurd; which leads us up to our second head.

II. Stock-Watering.—But, says Mr. Hudson, you can not really rob your stockholders, you know, because your stock is "water," and your capitalization "fictitious." Let us see about this. Many a good cause and many a good man have been slain by an epigram. It was a *coup d'esprit* of Wall Street to call the increased capitalization by a corporation a "watering" of its stock; and the phrase has doubtless often done yeoman service in the transactions by which Wall Street lives and thrives. But the old syllogism must be accepted very peremptorily here if we are to admit—because corporations sometimes do increase their capital on paper—that all railway companies are public enemies. Nobody can defend, and nobody ought to attempt to defend, the pouring of pure water into the capital stock of a corporation. But there are some four hundred railroad companies in these United States; and Mr. Hudson, to sustain the charge of universal watering against railway companies, instances two capital cases. One of these was one of the most flagrant cases on record (it would be difficult, indeed, to find one more flagrant). It dates back some twelve years; was first held up to public criticism by a gentleman who, more than any other one man, is in receipt of Mr. Hudson's constant and most unqualified strictures everywhere else in Mr. Hudson's pages for his own career as a railroad president; moreover, this very case became the moving cause of legislation which forever prevented a repetition of the particular process by which this particular stock was "watered." As to the other case cited by Mr. Hudson, the "watering," according to his own figures, amounted to one third of its increased capital. But I doubt if any shipper of the line of that particular railroad, or any patron of the line who remembers its previous condition, will agree with Mr. Hudson that a betterment of one third at least did not accrue at about the time of the "watering." Suppose a zigzag line of railways operated by half a dozen petty corporations, requiring endless delays, a change of cars for passengers and a breaking of freight bulks between two of the most important terminals in the country—metamorphosed into a system of four through tracks to conserve the safety of life and property by separating freight and passenger service. Suppose the improvement marked by increased prosperity, not only of the line but of the territory it traversed—would there have been no betterment to capitalize, or would the capitalizing of this betterment be "water"? Would stockholders, in such a case, be apt to object to the company borrowing money to make their own stock more valuable? And which is Mr. Hudson's public just now, the public along the line of this improved railway, and who pay its tariffs; or the entire continent from Sandy Hook to the Golden Gate, from Canada to the Gulf of Mexico, for whom Mr. Hudson assumes to take up his parable? Another curious fact which Mr. Hudson may not be aware of (or if aware of, which he has inadvertently omitted to clip and paste in just here) is the fact that at present, in 1887, these two selected corporations are members of the same pool, serving respective but almost parallel territory at rates at least thirty-three per cent lower than at the dates at which their recapitalizations occurred. Mr. Hudson's platitudes against "stock-watering," so long as he confines himself to platitudes and truisms merely, are perfectly safe. But when, in 1887, he prints the newspaper-clippings of 1872-'74, and moralizes therefrom, he can hardly complain if his public demur, not only to his antique instances, but to his general safety as a guide in the complicated questions with which he assumes to deal. I mention these two examples (which are now ancient history) not to suggest an excuse for them, but as showing how entirely superfluous Mr. Hudson's employment of them is; and how as a matter of fact the wrong, so far as the public is concerned, has been entirely neutralized by application of the pooling system. Other things being equal, there is no reason why a railroad should not capitalize its earnings by employing them for betterments, any more than that an individual should capitalize his by putting back his earnings into his business. Nor is it quite apparent that any moral dishonesty enters into the act of even capitalizing those betterments which Nature and the march of civilization bring, which I understand are called (just now) "the unearned increment." I do not remember that any company has so far been guilty of this particular sort of watering; but, had the early Dutch settlers of Manhattan Island built the present elevated railway, it is interesting to speculate what sin would have been committed against natural or moral law had their assigns in 1887 capitalized that structure, not at an approximate to its earning power at the date of its construction (in, say, 1666), but at a sum representative of its actual earning power in the later year. Neither am I aware by what mental processes one can insist on "unearned" increments at all, if by that popular term we mean the increase to one's property by the efforts or investments of one's neighbors. It is fashionable, I am aware, to say that if A's corner lot increases fifty per cent by reason of the purchase and improvement of adjoining lots by B, C, D, E, and F, that fifty percentage is A's unearned increment; but is A's foresight and shrewdness in investing in the corner lot aforesaid, when he might have placed his money elsewhere, to count for nothing? Are not brains a part of one's capital, and may not A's foresight and shrewdness have been and continued a considerable part of his capital or stock in trade or earning power? Assuming that Mr. Hudson does not contemplate the removal of cerebral inequality between man and man by due process of law, it might occur that whereas the rest of the alphabet had no confidence in the future of—let us say, a certain B and C Railroad—A might foresee a Pacific Railway, or a commercial development, or the bankruptcy of a competing line—which would make it valuable, and so might without sin buy up its stock at five cents on a dollar and in due time reap substantial rewards. And supposing even that A, by the transaction (or even by recapitalizing this same B and C Railroad), was ultimately enabled to accumulate one of those enormous fortunes in which Mr. Hudson sees such peril to his republic, would even such a public calamity go to prove railways public enemies, or that any and all increase of capitalization was "stock-watering"? Doubtless improper practices will obtain with evil-minded men until the end of time. But if the enormous fortunes aforesaid have been accumulated by watering railway-stocks, then it instantly follows that they have not been accumulated by the management and operation of railways; and thus another of Mr. Hudson's charges falls to the ground. And the facts are within this statement. As a matter of fact these accumulators of mammoth fortunes were operators in Wall Street, who by accident became loaded with a favorite security, or with the debentures or stock of a single corporation, which necessitated (or at least suggested) their identification or assumption of the management, directorship, or presidency of this, that, or the other railway corporation. In not a single case have these fortunes arisen from the earning power of the road itself. If a certain railway corporation increases its stock without proportionately increasing its earning power, then the transaction is properly characterized as "stock-watering." But it does not make all railways enemies of the republic, nor in any way cause them to "dominate" the people who have granted them franchises for transportation purposes. It is from a prevalence of the very spirit which Mr. Hudson's volume, "The Railways and the Republic," labors vigorously and constantly to cultivate in this people, that railway-wrecking and stock-watering ever become possible. If Mr. Hudson honestly desires to make stock-watering impossible, let him advise his constituency to yield the railways such tariffs as they are obliged to demand, thus enabling them to meet their fixed charges and so keep out of the hands of "speculative directors," who will, from private greed, proceed to "water" their stocks. Here is a field wherein Mr. Hudson could write books to his heart's content, from a consistent, public spirited, and even contemporary standpoint, and with the best results. The mere collecting of antique newspaper-clippings is, beyond the passing amusement of the hour, of very small utility, of trifling exemplary value, and certainly of not the slightest assistance whatever in solving the problem of the American railway.

III. Eminent Domain.—Mr. Hudson's definition of this facility of railroad companies is as follows: "To take away the property of A and give it to B for the latter's private use and behoof, provided always that B is a railway corporation" (page 114). Now, actually and practically, the above is a remarkably comprehensive and exact definition, not of eminent domain but of what eminent domain is not, and of what it never can be under any circumstances. Mr. Hudson himself has inadvertently told us what it really is: "Experience shows that no railroad twenty-five miles in length can be built without the resort to the power of the State, for there are always some proprietors who demand an exorbitant price, or altogether refuse to let the railway pass over their property. . . . No railroad of greater importance than a mere switch ever has been or ever can be built without invoking the sovereignty of the Government in its behalf" (page 111). Under such circumstances, where a man's neighbors have decided that they want a railway, the law—so far from taking anything from anybody—simply steps in and applies the well-known maxims that a man must use his own so as not to injure his neighbors; and that, in civilized communities, every citizen yields a fraction of his rights for the general good and society of all. To enable the railway to enforce the general consent, it is convenient to apply these maxims against the recalcitrant citizen by the fiction that the Government endows the railroad company—for the emergency and for the emergency only—with a portion of its own (the Government's) right to take the property of its subjects in cases of necessity (as for the public good in times of peace, or the public defense in time of war, etc.). This force is applied, however, not at the expense of the Government, nor even at the expense of the recalcitrant and unpleasant citizen who will not accord with his neighbors, but at the sole expense of the railway company. The result is that, instead of the citizen suffering for his obduracy and obstinacy, he is actually rewarded—since he ultimately receives a greater value for his land, without being mulcted in any of the expenses of the taking. So far as he is concerned he has lost nothing by his contumacy; whereas the railway, by his contumacy and without fault on its part, has been put to the costliest plan of acquiring the land. For the purchase of any strip of land, at almost any price, is invariably cheaper than the process of condemnation by private "view," which, both in time and money, is by all odds the very costliest known method of obtaining a railroad's right of way. These "views" are, by statutory requirement, made by persons of the vicinage, who, in estimating their neighbor's land, estimate their own; as individuals it can be readily imagined they are not over-solicitous to save the corporation expense, nor to estimate at all without liberal compensation to themselves for their own services: and the result can be readily computed. The laws of eminent domain, as appertaining to railway companies, and their operation in cases of land condemnation, are too technical to be elaborated here. But it may be said, as a matter of fact, that their application ceases with the single act of the acquirement of land. Nor is the power of the Government over the citizen ever, except in this solitary instance, exercised by the railway company from the beginning to the fine and term of its career; and, moreover, the grant itself is not only not against public policy and interest, but is directly in favor of the public: being positively granted to the railways as against themselves rather than in their favor, so far as a possible question between the railways and the public can possibly arise.

What is known as the police power of railways, which is derived from and determined by the local police power of each separate community, although sometimes granted by proclamation from the State Executive, since Mr. Hudson has not assailed it, I will not defend. In the granting of railway passes I confess my inability to discover a crime against the State. Wherein they differ from the orders that a manager issues to seats in a theatre—especially since his theatrical privileges come from the people by special license—I am unable to perceive. "Passes" are the small currency of the railway company, payable for favors not estimated in, or convertible to, money; and are used just as the small trader bestows an apple or a toy upon the juvenile carrier between his small customer and himself. The company's rule is to issue passes only for services; but the rule is construed liberally to apply to prospective as well as actual services, and to count presumed influence, or perhaps an assumed or expected favorable mention of the particular corporation issuing them as a service. But, even if issued for no service, real or prospective, I know of no human being, institution, or concern, public or private, that is not allowed to perform acts complimentary in their nature, or even entirely gratuitous. In the course of many years' experience I have seen fully as many acts of public charity as of private compliment performed by railway companies. A friendless and penniless woman, whose husband has been left behind or has deserted her, *en route* she knows not whither, can be transported to a desired destination, if not in the discretion of the conductor, at least by telegraphing for permission to the proper department. And there is not a railway in the country where such gratuitous services are not constant, and as unchronicled and unheralded as they are constant. While I frankly say that, for one, I can not see where the granting either of charities or of "passes" militates against the public character imposed by Legislatures upon railroads, or is forbidden by the fact that to facilitate its construction the railway company once enjoyed a parcel of the State's power of eminent domain; I must admit that (except as to employés) the system has always been a nuisance to the railway companies which they have constantly labored to abolish. It is impossible to forecast what quantum of credit Mr. Hudson and his kind may take unto themselves for the Interstate Commerce Act, which has at last promised the railways a grateful relief from the pass-beggar. But if that act shall abolish both pools and passes, public sympathy will be with the honest shipper who must pay increased tariffs, rather than with the local Solon who wakes to find that—while screaming at "discriminations" and "long and short hauls"—he has actually been emptying his own pockets of the passes with which they were lined.

The power of the Government over the citizen, then, except in this solitary instance of land condemnation, being never exercised by a corporation: being bestowed invariably and always for the benefit and in the interest of the people, and not of the railway company; taking always the shape of a duty and never the shape of a privilege—granted that railroads are *quasi*-public corporations, it would appear to follow —since they are only *quasi*-public, that they have still some elements of a private nature; and (since it is their private and not their public character which continues) that it is by this private character they must be continually judged. Granted that they must carry freights for the public in such a way as not to injure either the public or the freight in the carrying, most emphatically (it seems to me) it does not follow that they must add to the value of the freights they carry by charging only such rates as the public, or the owners of the freight, insist on. Mr. Hudson, as a member of society, has a presumptive right to light and air; to life, liberty, and the pursuit of happiness. Supposing that society should pass one law affirmatively compelling Mr. Hudson to recognize his neighbor's rights to life, liberty, and the pursuit of happiness; and, on top of that, another restraining him from interfering with these rights; still another compelling him to positively contribute in cash or services to the life, liberty, and the pursuit of happiness of his neighbors; and add to all these a still further law taking away his (Mr. Hudson's) own life, liberty, etc., because he had not in the past so contributed? Would not Mr. Hudson begin after a while to consider the propriety of looking up his own constitutional privileges; or, possibly, the charter of the particular society that was enacting all these statutes?—or query, perhaps, if the mere grant of power to breathe himself were a fair consideration for the burden of seeing to it that the entire neighborhood breathed? But our laws are daily imposing upon the railway companies they have chartered (on account of this so-called *quasi*-public character which the once granting of this long-lapsed power of eminent domain has saddled upon them) the duty of carrying whatever of passengers or freight is offered—of reasonably accommodating the public—of forfeiture of their charter if, even at a loss, trains are not so run as to accommodate reasonably; of operating, whether at a profit or at a deficit (under penalties for refusal to perform services desired of them)—under a burden of proof always to prove a negative if the refusal is alleged of them—under a disadvantage always before a jury—and of being obliged to accept the jury always of the locality where ideas of value and damage are the largest. Liabilities always to patrons, servants, abutters and adjoiners; to the State; compelled to pay damages for accidents caused by trespasses on their own rights of way; to maintain alert and vigilant counsel always to watch, lest at any moment they inadvertently overlook any of the thousands of statutes that thirty-eight Legislatures are annually pouring from the legislative mill; black-mailed on every hand, and always under the conviction that the average citizen sees no dishonesty in getting the better of them by dodging fares, or getting passes under false pretenses; and, if they receive a public gift of land, having it at once construed against them and carried to defend it against the grantor himself in the grantor's own courts—these are the least of the burdens which this once granted and quickly terminated privilege of eminent domain is supposed to impose, and practically does impose, upon railway companies. Admitting their public character—even such a character is, perhaps, not morally a deterrent to the rights of their stockholders to get the interest on their investment; or otherwise a displacement of the unwritten law of *meum* and *tuum*. Railroads, by the uniform decisions of half a century, are indeed public conveniences. But, so far, this character of a public convenience has been only a burden, never a blessing, or even a shield. The man who steals a ride on a railway-train and imputes it to himself for sin would be a curiosity. The railway company has no conscience-fund; and, had it, there would be no contributors. It may submit to robbery, may carry for less than the cost of the service, and so plunder its stockholders to its heart's content, and Mr. Hudson and his clique have no protest to put on record. But if under all this load the railway company succumbs to bankruptcy, Mr. Hudson, from his elastic standpoint (or rather from his lack of any standpoint whatever) is enabled to cite this very bankruptcy as another instance of the hostility and danger of railways to the republic. He has charged them with being enemies to the public, firstly, because of their tariffs. He charges them, secondly, with being public enemies because of the bankruptcy which a failure to collect those tariffs has brought upon them; and yet again, thirdly—when that bankruptcy has made the stock nominal in value and so speculative, and a shrewd operator absorbs it and so lays the foundation of a private fortune—Mr. Hudson still charges the railways with being public enemies because the far-seeing operator has accumulated this very private fortune! Moreover, he lumps the whole *catena* of cause and effect into a series of indictments (or, more absurdly still, into a series of specifications under a single indictment against railways as a class or an institution), and proposes as a relief from the whole—what? Why, that the Government confiscate (or purchase by way of condemnation) these railways, and make them a public highway upon which any one may run his own rolling-stock on payment of a trackage-fee!

I know what the railways of this continent are, what services they perform. I know that, by vigilant watch for and adoption of the latest triumphs of engineering and mechanical skill, and by employment of the costliest of expert assistance, they have reduced the percentage of accident to a minimum, and the chances of loss of life to a fraction so small that it is actually a mathematical truth to assert that a man is safer in a railway-train running at full speed than in his bed, or in any other spot on this most precarious globe! What these railways could become if operated upon Mr. Hudson's plan I can not question; the details of that picture I can not, for one, fill in. I know not what terminal facilities, what time-tables, or what percentage of slaughter would be necessary did every man, woman, and child possess the inalienable right to place upon their tracks their own locomotives, their own passenger-coaches and freight-carriages, and to run them at their own sweet will hither and thither. Nor can my fancy devise where all this rolling-stock would be stored when not in use (unless, indeed, means were devised to suspend it, by balloons or other aërial contrivance, over the railways themselves). Mr. Hudson does not discuss these questions at all, but leaves them, possibly, to the inventive genius of the race. And there, perhaps, we may also rest them.

But, taking leave of Mr. Hudson and his chimera, we have yet before us the railways themselves. Against the inequality of their own rates and the hardship of the long and short haul (in other words, against the discriminations of Nature and of physical laws), no less than against the peril of bankruptcy and the consequent speculative tendency of their stocks (after which may come the wrecking, the watering, and the vast individual fortunes), the railways of this republic have endeavored, by establishment of pool commissions, to defend both the public and themselves; and, whatever their motive may have been, their record as to that can not be disturbed. As to the effect of the Interstate Commerce Law upon the shipper and the passenger, time and trial alone can testify. But it is precisely such literature as Mr. Hudson's, and the sentiment it manufactures, which have made railway-wrecking, stock-watering, and their concomitant disasters possible; while for these disasters, down to date at least, the pool has been found the only and entirely adequate remedy. That remedy, drastic as it is, the railways (far from being public enemies) have themselves applied. The honest administration of railways for all interests, the payment of their fixed charges, the solvency of their securities, the faithful and valuable performance of their duties as carriers, can be conserved in but one way—by living tariffs such as the pools have guaranteed. But we want no living tariffs, says our Mr. Hudson. Give us a governmental control, and we will pay no tariffs—only a trackage-fee! Supposing this revolution accomplished, and how many years or months would, perhaps, elapse before another declamation in five hundred more pages of close type against the excessive trackage-fees, the favors to public officials or private cronies, or a formulated demand that the Government provide terminals at its own expense (another planet, possibly), sumptuous rolling-stock, motive power, and accident insurance policies for its passengers would arrive from the constant, sleepless, and irrepressible Mr. Hudson? Is it not, after all, Mr. Hudson and his kind—and not the Wall Street operator who trades on the sham public opinion they manufacture—who are the true stock-waterers, railroad-wreckers, and enemies of this republic?

# SOME HUMAN INSTINCTS.

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IT is generally considered that a cardinal *differentia* of the human race is its poor endowment in the way of instincts. Brutes need instincts, it is supposed, because they have no reason. But man, with his reason, can do without instincts. "Instinctive actions," says Professor Preyer, in his careful little work, "Die Seele des Kindes," "are in man few in number, and, apart from those connected with the sexual passion, difficult to recognize after early youth is past. So much the more attention," he adds, "should science pay to the instinctive actions of young children."

I believe this doctrine to be a great mistake. Instead of having fewer, man has more instincts than any other mammal. He has so many that they bar one another's path, and produce an indeterminateness of action in him, supposed to be incompatible with that automatic uniformity which, according to popular belief, characterizes all instinctive performances. Popular belief is here in error. The more carefully instincts have been studied of late years, and the more clearly their mechanism has been laid bare, the more evident has it become that their effects are liable to be modified by various conditions. Instincts are due, at bottom, to the organization in the nerve-centers of certain paths of discharge, or reflex-arcs, as they are technically called. The disturbance produced in the way of sound, light, or other sensible emanation, by some object in the environment, runs in at an animal's senses, and then out through his muscles. Each special sort of disturbance or stimulus affects a special set of muscles, and makes the animal act in a special way, he knows not why, except that it seems the only natural way to act at the moment. Witness the fear of a natural enemy, the love of the opposite sex, the pursuit of a natural prey. Some of these reflex-arcs are transient. Some of the environing objects stimulate more than one arc at once (as when the presence of a strange dog awakens timorous, pugnacious, and sociable movements, all at the same time, in another dog), and then small accidents determine the resultant path of discharge. Finally, habits are formed of reacting on one particular object of a kind, and inhibit the application of the instinct to other individuals (limitation of the sexual instinct to one mate, etc.). In an article published elsewhere,* I have tried to trace these complications and variations, and to show that the presence of too many instincts in a creature, some of them transient, some of them tending in opposite ways, some of them inhibited in their application by the habits earliest formed, must needs produce a

* "Scribner's Magazine," March, 1887.

life, as unautomatic and ununiform in its outward aspect, as human life has ever been claimed to be.

In this article and a later one, I will run over the human instincts in detail, commenting with fullness only upon such as are interesting enough to repay the pains.

The line to be drawn between simply reflex and instinctive actions is an entirely arbitrary one ; so I can see no objection, on the score of principle, to including under the title of instincts Professor Preyer's whole list of the gradually evolving propensities to action of the human babe : *Sucking, biting, spitting, making grimaces, clasping, pointing, making sounds expressive of desire, carrying objects to the mouth, averting head and body, sitting up, standing,* are all accomplishments which come in due order, and lead us to the locomotor age. Each is irresistibly called forth by some appropriate stimulus, and finally becomes subject to the conscious will.

*Locomotion* is more interesting. Until the walking impulse ripens in the nerve-centers, the legs remain limp and indifferent, no matter how often the child may be hung with his feet in contact with the ground. No sooner, however, has the standing instinct come, than the child stiffens his legs and presses downward as soon as his feet feel the floor. In some babies this is the earliest locomotor reaction. In others it is preceded by the impulse to *creep*. Yesterday, the baby sat contentedly wherever he was put. To-day, it is impossible to keep him sitting at all, so irresistible is his impulse to throw himself forward on his hands. Usually the arms are too weak, and the ambitious little experimenter falls on his nose. But his perseverance is dauntless, and he soon learns to travel in the quadrupedal way. The *walking* instinct may awaken with no less suddenness, and its entire education be completed within a week's compass, barring a little "grogginess" in the gait. The common belief that a baby *learns* to walk is, strictly speaking, untrue. The reflex machinery, as it begins to ripen, prompts him to its use. But, as it is imperfectly organized, he makes mistakes. If, however, a baby could be prevented from getting on his feet at all for a fortnight or so after his first impulse to do so had manifested itself, and then restored to freedom, I have little doubt of his then being able to walk perfectly, or almost perfectly, "from the word 'go.'" A small blister on each foot-sole would do the business ; and it is much to be desired that some scientific widower, left alone with his infant at the critical moment, should repeat on the human species the brilliant observation of Mr. Douglas Spalding on various small birds, which he kept till they were fully fledged, and then found to fly with absolute perfection the first time he allowed them to spread their wings. Usually, birds start to fly before either the central or peripheral apparatus is quite ripe. And so do we, to walk.

Of *vocalization* I will say nothing except that it is instinctive in both of its forms, singing and speech, and that the propensity to speak often ripens in a child with almost startling suddenness. A few significant sounds are gradually acquired, but the vocabulary is very small until the impulse of imitating sounds awakes. When its awakening is abrupt it is impossible to talk with the child. His condition is that of *echolalia:* instead of answering, he repeats the question. His whole energy may for a few days be poured into this channel, and during those days the foundations of his future vocabulary are laid.

*Imitation* is a human instinct which has other fields of application than the vocal one. Say what one will of monkeys, man is the imitative animal. Civilization, in fact, depends on the trait. *Nil humani a me alienum*, is the motto of each of us, and we are uneasy when another shows any power or superiority, till we can exhibit it ourselves as well. Much might be said of this propensity, as well as of the impulse to *rivalry* which is akin to it, and equally instinctive ; but I must hasten on to—

*Sympathy* is an emotion as to whose instinctiveness psychologists have held hot debate, some of them contending that it is no primitive endowment, but, originally at least, the result of a rapid calculation of the good consequences to ourselves of the sympathetic act. Such a calculation, at first conscious, would grow more unconscious as it became more habitual, and at last, tradition and association aiding, might prompt to actions which could not be distinguished from immediate impulses. It is hardly needful to argue against the falsity of this view. Some forms of sympathy, that of mother with child, for example, are surely primitive, and not intelligent forecasts of support to be reaped in old age. Danger to the child blindly and instantaneously stimulates the mother to actions of alarm or defense. Menace or harm to the adult, beloved, and friend, excites us in a corresponding way, often against all the dictates of prudence. It is true that sympathy does not necessarily follow from gregariousness. Sheep and cattle do not help a wounded comrade ; on the contrary, they are more likely to dispatch him. But a dog will lick another sick dog, and even bring him food ; and the sympathy of monkeys is proved by many observations to be strong. In man, then, we may lay it down that the sight of suffering or danger to others is a direct exciter of interest, and an immediate stimulus, if no complication hinders, to acts of relief. There is nothing unaccountable or pathological about this—nothing to justify Professor Bain's assimilation of it to the "fixed ideas" of insanity, as "clashing with the regular outgoings of the will." It may be as primitive as any other "outgoing," and may be due to a random variation selected, quite as probably as, in Spencer's opinion, gregariousness and maternal love are due to such variations.

It is true that sympathy is peculiarly liable to inhibition from other instincts which its stimulus may call forth. The traveler whom the good Samaritan rescued may well have prompted such instinctive fear or disgust in the priest and Levite who passed him by, that their sympathy could not come to the front. Then, of course, habits, reasoned reflections, and calculations may either check or re-enforce; as may also the instincts of love or hate, if these exist, for the suffering individual. The hunting and pugnacious instincts, when aroused, also inhibit our sympathy absolutely. This accounts for the cruelty of collections of men hounding each other on to bait or torture a victim. The blood mounts to the eyes, and sympathy's chance is gone.

*Pugnacity and anger.* In many respects man is the most ruthlessly ferocious of beasts. As with all gregarious animals, "two souls," as Faust says, "dwell within his breast," the one of sociability and helpfulness, the other of jealousy and antagonism to his mates. Though in a general way he can not live without them, yet, as regards certain individuals, it often falls out that he can not live with them either. Constrained to be a member of a tribe, he still has a right to decide, as far as in him lies, of which other members the tribe shall consist. Killing off a few obnoxious ones may often better the chances of those that remain. And killing off a neighboring tribe from whom no good thing comes, but only competition, may materially better the lot of the whole tribe. Hence the gory cradle, the *bellum omnium contra omnes*, in which our race was reared; hence the fickleness of human ties, the ease with which the foe of yesterday becomes the ally of to-day, the friend of to-day the enemy of to-morrow; hence the fact that we, the lineal representatives of the successful enactors of one scene of slaughter after another, must, whatever more pacific virtues we may also possess, still carry about with us, ready at any moment to burst into flame, the smoldering and sinister traits of character by means of which they lived through so many massacres, harming others, but themselves unharmed.

*The hunting instinct* has an equally remote origin in the evolution of the race. The hunting and the fighting instinct combine in mány manifestations. They both support the emotion of anger; they combine in the fascination which stories of atrocity have for most minds; and the utterly blind excitement of giving the rein to our fury when our blood is up (an excitement whose intensity is greater than that of any other human passion save one), is only explicable as an impulse aboriginal in character, and having more to do with immediate and overwhelming tendencies to muscular discharge than to any possible reminiscences of effects of experience, or association of ideas. I say this here, because the pleasure of disinterested cruelty has been thought a paradox, and writers have sought to show that it is no primitive attribute of our nature, but either a semblance or a resultant of the subtile combination of other less malignant elements of mind. This is a hopeless task. If evolution and the survival of the fittest be true at all, the destruction of prey and of human rivals *must* have been among the most important of man's primitive functions, the fighting and the chasing instincts *must* have become ingrained. Certain perceptions *must* immediately, and without the intervention of inferences and ideas, have prompted emotions and motor discharges; and both of the latter must, from the nature of the case, have been very violent, and therefore, when unchecked, of an intensely pleasurable kind. It is just because human bloodthirstiness is such a primitive part of us that it is so hard to eradicate, especially where a fight or a hunt is promised as part of the fun.*

As Rochefoucauld says, there is something in the misfortunes of our very friends that does not altogether displease us; and an apostle of peace will feel a certain vicious thrill run through him, and enjoy a vicarious brutality, as he turns to the column in his newspaper at the top of which "shocking atrocity" stands printed in large capitals. See how the crowd flocks round a street-brawl! Consider the enormous annual sale of revolvers to persons, not one in a thousand of whom has any serious intention of using them, but of whom each one has his carnivorous self-consciousness agreeably tickled by the notion, as he clutches the handle of his weapon, that he will be rather a dangerous customer to meet. See the ignoble crew that escorts every great pugilist—parasites who feel as if the glory of his brutality rubbed off upon them, and whose darling hope, from day to day, is to arrange some set-to of which they may share the rapture without enduring the pains! The first blows at a prize-fight are apt to make a refined spectator sick; but his blood is soon up in favor of one party, and it will then seem as if the other fellow could not be banged and pounded and mangled enough—the refined spectator would like to re-

* It is not surprising, in view of the facts of animal history and evolution, that the very special object blood should have become the stimulus for a very special interest and excitement. That the sight of it should make people faint is strange. Less so that a child who sees his blood flow should forthwith become much more frightened than by the mere feeling of the cut. Horned cattle often, though not always, become furiously excited at the smell of blood. In some abnormal human beings the sight or thought of it exerts a baleful fascination. "B and his father were at a neighbor's one evening, and, while paring apples, the old man accidentally cut his hand so severely as to cause the blood to flow profusely. B was observed to become restless, nervous, pale, and to have undergone a peculiar change in demeanor. Taking advantage of the distraction produced by the accident, B escaped from the house and proceeded to a neighboring farm-yard, where he cut the throat of a horse, killing it." Dr. D. H. Tuke, commenting on this man's case ("Journal of Mental Science," October, 1885), speaks of the influence of blood upon him—his whole life had been one chain of cowardly atrocities—and continues: "There can be no doubt that with some individuals it constitutes a fascination. . . . We might speak of a *mania sanguinis*. Dr. Savage admitted a man from France into Bethlehem Hospital some time ago, one of whose earliest symptoms of insanity was the thirst for blood, which he endeavored to satisfy by going to an abattoir in Paris. The man whose case I have brought forward had the same passion for gloating over blood, but had no attack of acute mania. The sight of blood was distinctly a delight to him, and at any time blood aroused in him the worst elements of his nature. Instances will easily be recalled in which murderers, undoubtedly insane, have described the intense pleasure they experienced in the warm blood of children."

enforce the blows himself. Over the sinister orgies of blood of certain depraved and insane persons let a curtain be drawn, as well as over the ferocity with which otherwise fairly decent men may be animated, when (at the sacking of a town, for instance), the excitement of victory long delayed, the sudden freedom of rapine and of lust, the contagion of a crowd, and the impulse to imitate and outdo, all combine to swell the blind drunkenness of the killing-instinct, and carry it to its extreme. No! those who try to account for this from above downward, as if it resulted from the consequences of the victory being rapidly inferred, and from the agreeable sentiments associated with them in the imagination, have missed the root of the matter. Our ferocity is blind, and can only be explained from *below*. Could we trace it back through our line of descent, we should see it taking more and more the form of a fatal reflex response, and at the same time becoming more and more the pure and direct emotion that it is.

In childhood it takes this form. The boys who pull out grasshoppers' legs and butterflies' wings, and disembowel every frog they catch, have no *thought* at all about the matter. The creatures tempt their hands to a fascinating occupation, to which they have to yield. It is with them as with the "boy-fiend" Jesse Pomeroy, who cut a little girl's throat, "just to see how she'd act." The normal provocatives of the impulse are all living beasts, great and small, toward which a contrary habit has not been formed—all human beings in whom we perceive a certain *intent* toward *us*, and a large number of human beings who offend us peremptorily, either by their look, or gait, or by some circumstance in their lives which we dislike. Inhibited by sympathy, and by reflection calling up impulses of an opposite kind, civilized men lose the habit of acting out their pugnacious instincts in a perfectly natural way, and a passing feeling of anger, with its comparatively faint bodily expressions, may be the limit of their physical combativeness. Such a feeling as this may, however, be aroused by a wide range of objects. Inanimate things, combinations of color and sound, bad bills of fare, may in persons who combine fastidious taste with an irascible temperament, produce real ebullitions of rage. Though the female sex is often said to have less pugnacity than the male, the difference seems connected more with the extent of the motor consequences of the impulse than with its frequency. Women take offense and get angry, if anything, more easily than men, but their anger is inhibited by fear, and other principles of their nature, from expressing itself in blows. The hunting-instinct proper seems to be decidedly weaker in them than in men. The latter instinct is easily restricted by habit to certain objects, which become legitimate "game," while other things are spared. If the hunting-instinct be not exercised at all, it may even entirely die out, and a man may enjoy letting a wild creature live, even though he might easily kill him. Such a type is now becoming frequent; but there is no doubt that in the eyes of a child of Nature such a personage would seem a sort of moral monster.

*Fear* is a reaction aroused by the same objects that arouse ferocity. The antagonism of the two is an interesting study in instinctive dynamics. We both fear, and wish to kill, anything that may kill us; and the question which of the two impulses we shall follow, is usually decided by some one of those *collateral circumstances* of the particular case, to be moved by which is the mark of superior mental natures. Of course, this introduces uncertainty into the reaction; but it is an uncertainty found in the higher brutes as well as in men, and ought not to be taken as proof that we are less instinctive than they. Fear has bodily expressions of an extremely energetic kind, and stands, beside lust and anger, as one of the three most exciting emotions of which our nature is susceptible. The progress from brute to man is characterized by nothing so much as by the decrease in frequency of proper occasions for fear. In civilized life, in particular, it has at last become possible for large numbers of people to pass from the cradle to the grave without ever having had a pang of genuine fear. Many of us need an attack of mental disease to teach us the meaning of the word. Hence the possibility of so much blindly optimistic philosophy and religion. The atrocities of life become "like a tale of little meaning though the words are strong"; we doubt if anything like *us* ever really was within the tiger's jaws, and conclude that the horrors we hear of are but a sort of painted tapestry for the chambers in which we lie so comfortably at peace with ourselves and with the world.

Be this as it may, fear is a genuine instinct, and one of the earliest shown by the human child. *Noises* seem especially to call it forth. Most noises from the outer world, to a child bred in the house, have no exact significance. They are simply startling. To quote a good observer, M. Perez:

Children between three and ten months are less often alarmed by visual than by auditory impressions. In cats, from the fifteenth day, the contrary is the case. A child, three and a half months old, in the midst of the turmoil of a conflagration, in presence of the devouring flames and ruined walls, showed neither astonishment nor fear, but smiled at the woman who was taking care of him, while his parents were busy. The noise, however, of the trumpet of the firemen, who were approaching, and that of the wheels of the engine, made him start and cry. At this age I have never yet seen an infant startled at a flash of lightning, even when intense; but I have seen many of them alarmed at the voice of the thunder. . . . Thus, fear comes rather by the ears than by the eyes, to the child without experience. It is natural that this should be reversed, or reduced, in animals organized to perceive danger afar. Accordingly, although I have never seen a child frightened at his first sight of fire, I have many a time seen young dogs, young cats, young chickens, and young birds frightened thereby. . . . I picked up some years ago a lost cat about a year old. Some months afterward at the onset of cold weather I lit the fire in the grate of my study, which was her reception-room. She first looked at the flame in a very frightened way. I brought her near to it. She leaped away and ran to hide under the bed. Although the fire was lighted every day, it was not until the end of the winter that I could prevail upon her to stay upon a chair near it. The next winter, however, all apprehension had disappeared. . . . Let us, then, conclude that there are hereditary dispositions to fear, which are independent of experience, but which experiences may end by attenuating very considerably. In the human infant I believe them to be particularly connected with the ear.*

The effect of noise in heightening any terror we may feel in adult years is very marked. The *howling* of the storm, whether on sea or land, is a principal cause of our anxiety when exposed to it. The writer has been interested in noticing in his own person, while lying in bed, and kept awake by the wind outside, how invariably each loud gust of it arrested momentarily his heart. A dog, attacking us, is much more dreadful by reason of the noises he makes.

*Strange men*, and *strange animals*, either large or small, excite fear, but especially men or animals advancing toward us in a threatening way. This is entirely instinctive and antecedent to experience. Some children will cry with terror at their very first sight of a cat or dog, and it will often be impossible for weeks to make them touch it. Others will wish to fondle it almost immediately. Certain kinds of "vermin," especially spiders and snakes, seem to excite a fear unusually difficult to overcome. It is impossible to say how much of this difference is instinctive and how much the result of stories heard about these creatures. That the fear of "vermin" ripens gradually seemed to me to be proved in a child of my own to whom I gave a live frog once, at the age of six to eight months, and again when he was a year and a half old. The first time, he seized it promptly, and holding it, in spite of its struggling, at last got its head into his mouth. He then let it crawl up his breast, and get upon his face, without showing alarm. But the second time, although he had seen no frog and heard no story about a frog between whiles, it was almost impossible to induce him to touch it. Another child, a year old, eagerly took some very large spiders into his hand. At present he is afraid, but has been exposed meanwhile to the teachings of the nursery. Preyer tells of a young child screaming with fear on being carried near to the *sea*.

*Solitude* is a source of terror to infancy. The teleology of this is obvious, as is also that of the infant's expression of dismay—the never-failing cry—on waking up and finding himself alone.

* "Psychologie de l'Enfant," pp. 72-74, in an account of a young gorilla quoted from Falkenstein, by R. Hartmann ("Anthropoid Apes," "International Scientific Series," vol. lii, New York, 1886, page 265), it is said: "He very much disliked strange noises. Thunder, the rain falling on the skylight, and especially the long-drawn note of a pipe or trumpet, threw him into such agitation as to cause a sudden affection of the digestive organs, and it became expedient to keep him at a distance. When he was slightly indisposed, we made use of this kind of music with results as successful as if we had administered purgative medicine."

*Black things*, and especially *dark places*, holes, caverns, etc., arouse a peculiarly gruesome fear. This fear, as well as that of solitude, of being "lost," are explained after a fashion by ancestral experience. Says Schneider:

It is a fact that men, especially in childhood, fear to go into a dark cavern or a gloomy wood. This feeling of fear arises, to be sure, partly from the fact that we easily suspect that dangerous beasts may lurk in these localities—a suspicion due to stories we have heard and read. But, on the other hand, it is quite sure that this fear at a certain perception is also directly inherited. Children who have been carefully guarded from all ghost-stories are nevertheless terrified and cry if led into a dark place, especially if sounds are made there. Even an adult can easily observe that an uncomfortable timidity steals over him in a lonely wood at night, although he may have the fixed conviction that not the slightest danger is near.

This feeling of fear occurs in many men even in their own house after dark although it is much stronger in a dark cavern or forest. The fact of such instinctive fear is easily explicable when we consider that our savage ancestors through innumerable generations were accustomed to meet with dangerous beasts in caverns, especially bears, and were for the most part attacked by such beasts during the night and in the woods, and that thus an inseparable association between the perceptions of darkness of caverns and woods, and fear took place, and was inherited.*

*High places* cause fear of a peculiarly sickening sort, though here, again, individuals differ enormously. The utterly blind, instinctive character of the motor impulses here is shown by the fact that they are almost always entirely unreasonable, but that reason is powerless to suppress them. That this is a mere incidental peculiarity of the nervous system, like liability to sea-sickness, or love of music, with no teleological significance, seems more than probable. The impulse is so much of an individual idiosyncrasy, and its detrimental effects are so much more obvious than its uses, that it is hard to see how it could be a selected instinct. Man is anatomically one of the best fitted of animals for climbing about high places. The best psychical complement to this equipment would seem to be a "level head" when there, not a dread of going there at all. In fact, the teleology of fear, beyond a certain point, is very dubious. Professor Mosso, in his interesting monograph, "La Paura" (which has recently been translated into French), concludes that many of its manifestations must be considered pathological rather than useful; Bain, in several places, expresses the same opinion; and this, I think, is surely the view which any observer without *a priori* prejudices must take. A certain amount of timidity obviously adapts us to the world we live in, but the *fear-paroxysm* is surely altogether harmful to him who is its prey.

Fear of the supernatural is one variety of fear. It is difficult to assign any normal object for this fear, unless it were a genuine ghost.

* "Der Menschliche Wille," p. 224.

But, in spite of psychical research-societies, science has not yet adopted ghosts ; so we can only say that certain *ideas* of supernatural agency, associated with real circumstances, produce a peculiar kind of horror. This horror is probably explicable as the result of a combination of simpler horrors. To bring the ghostly terror to its maximum, many usual elements of the dreadful must combine, such as loneliness, darkness, inexplicable sounds, especially of a dismal character, moving figures half discerned (or, if discerned, of dreadful aspect), and a vertiginous baffling of the expectation. This last element, which is *intellectual*, is very important. It produces a strange emotional "curdle" in our blood to see a process, with which we are familiar, deliberately taking an unwonted course. Any one's heart would stop beating if he perceived his chair sliding unassisted across the floor. The lower animals appear to be sensitive to the mysteriously exceptional as well as ourselves. My friend Professor W. K. Brooks, of the Johns Hopkins University, told me of his large and noble dog being frightened into a sort of epileptic fit by a bone being drawn across the floor by a thread which the dog did not see. Darwin and Romanes have given similar experiences.* The idea of the supernatural involves that the usual should be set at naught. In the witch and hobgoblin supernatural, other elements still of fear are brought in—caverns, slime and ooze, vermin, corpses, and the like.† A human corpse seems normally to produce an instinctive dread, which is no doubt somewhat due to its mysteriousness, and which familiarity rapidly dispels. But, in view of the fact that cadaveric, reptilian, and underground horrors play so specific and constant a part in many nightmares and forms of delirium, it seems not altogether unwise to ask whether these forms of dreadful circumstance may not at a former period have been more normal objects of the environment than now. The ordinary cock-sure evolutionist ought to have no difficulty in explaining these terrors, and the scenery that provokes them, as relapses into the consciousness of the cave-men, a consciousness usually overlaid in us by experiences of more recent date.

There are certain other pathological fears, and certain peculiarities

* "Cf. Romanes, "Mental Evolution," etc., p. 156.

† In the "Overland Monthly" for this year, a most interesting article on Laura Bridgman's writings has been published by Mr. E. C. Sandford. Among other reminiscences of her early childhood, while she still knew nothing of the sign-language, the wonderful blind deaf-mute records the following item : "My father [he was a farmer and probably did his own butchering] used to enter his kitchen bringing some killed animals in and deposited them on one of sides of the room many times. As I perceived it it make me shudder with terror because I did not know what the matter was. I hated to approach the dead. One morning I went to take a short walk with my Mother. I went into a snug house for some time. They took me into a room where there was a coffin. I put my hand in the coffin & felt something so queer. It frightened me unpleasantly. I found something dead wrapped in a silk h'd'k'f so carefully. It must have been a body that had had vitality. . . . I did not like to venture to examine the body for I was confounded."

in the expression of ordinary fear, which might receive an explanatory light from ancestral conditions, even infra-human ones. In ordinary fear, one may either run, or remain semi-paralyzed. The latter condition reminds us of the so-called death-shamming instinct shown by many animals. Dr. Lindsay, in his work on "Mind in Animals," says this must require great self-command in those that practice it. But it is really no feigning of death at all, and requires no self-command. It is simply a terror-paralysis which has been so useful as to become hereditary. The beast of prey does not think the motionless bird, insect, or crustacean dead. He simply fails to notice them at all; because his senses, like ours, are much more strongly excited by a moving object than by a still one. It is the same instinct which leads a boy playing "I spy" to hold his very breath when the seeker is near, and which makes the beast of prey himself in many cases motionlessly lie in wait for his victim or silently "stalk" it, by rapid approaches alternated with periods of immobility. It is the opposite of the instinct which makes us jump up and down and move our arms when we wish to attract the notice of some one passing far away, and makes the shipwrecked sailor frantically wave a cloth upon the raft where he is floating when a distant sail appears. Now, may not the statue-like, crouching immobility of some melancholiacs, insane with general anxiety and fear of everything, be in some way connected with this old instinct? They can give no *reason* for their fear to move; but immobility makes them feel safer and more comfortable. Is not this the mental state of the "feigning" animal?

Again, take the strange symptom which has been described of late years by the rather absurd name of *agoraphobia*. The patient is seized with palpitation and terror at the sight of any open place or broad street which he has to cross alone. He trembles, his knees bend, he may even faint at the idea. Where he has sufficient self-command he sometimes accomplishes the object by keeping safe under the lee of a vehicle going across, or joining himself to a knot of other people. But usually he slinks round the sides of the square, hugging the houses as closely as he can. This emotion has no utility in a civilized man, but when we notice the chronic agoraphobia of our domestic cats, and see the tenacious way in which many wild animals, especially rodents, cling to cover, and only venture on a dash across the open as a desperate measure—even then making for every stone or bunch of weeds which may give a momentary shelter—when we see this we are strongly tempted to ask whether such an odd kind of fear in us be not due to the accidental resurrection, through disease, of a sort of instinct which may in some of our ancestors have had a permanent and on the whole a useful part to play?

In a subsequent paper I shall try to consider man's remaining instincts in a similar way.

# THEOLOGY UNDER ITS CHANGED CONDITIONS.

By Rev. CANON FREMANTLE.

A PROFESSOR of divinity who has been thought at times to be by no means insensible to a reputation for orthodoxy, preaching in the University of Oxford a few days ago, said : "The field of speculative theology may be regarded as almost exhausted ; we must be content henceforward to be Christian agnostics." It is probable that these words, had they been uttered in the same place twenty-five years ago, would have excited an alarm comparable to that which was raised by Bishop Colenso or the "Essays and Reviews." In the present case they appear to have been accepted without a murmur ; so great is the change which has come over the conditions of theological thought in England in a quarter of a century. It will be the object of the present paper to make clear what are the new conditions of which theology has to take note, to point out what they involve either certainly or by probable inference, and to show what we may expect theology to be under these new conditions.

It is very necessary that such an attempt should be made, so that illusions should cease, and also unnecessary alarms ; and that theologians should strike boldly into the new paths, not reverting to unfruitful methods which separate theology from other parts of human knowledge. For it is to be observed that such utterances as that just quoted are met with again and again, even when least expected, in theological literature, but that this has by no means prevented the prevalence of dogmatism. St. Augustine wrote, in his treatise on "Christian Doctrine" :

> God is unspeakable; yet what we say of him would not be spoken at all if it were unspeakable. Even when we say God is unspeakable, we hardly speak rightly; for even in saying this we make an assertion. By pronouncing the word *Deus*, we do not make him known as he is. Only when that sound strikes the ears of men who know Latin, it moves in them the thought of a certain most excellent and immortal nature.

Yet this did not hinder him from repeating the language in which he had suddenly checked himself, and his methods have so enchained the study of theology that we are only now beginning to free ourselves from them. The melancholy experience of the sixteenth century which turned the Reformation from a great act of emancipation into a renewed scholasticism must not be repeated in our day.

The conditions which it is necessary to notice may be taken under four heads : 1. Those imposed by the advance of science, and 2. Of criticism ; 3. Those made by the altered state of church-life ; 4. Those caused by social and democratic progress.

1. Under the head of Science we may notice as specially bearing

on theology the fuller knowledge of the laws of nature with the increasing sense of their uniformity which imposes itself as a necessary condition of thought wherever things physical are concerned; the hypothesis of evolution, which suggests an account in harmony with this uniformity of the genesis of the whole animate creation; and, turning to another department, the history of religion, of which so much more is know now than formerly. 2. In referring to criticism we may dwell upon the discoveries recently made as to the dates of the books of the Old Testament, and the consequent rearrangement of Hebrew literature and history; the views now given by scholars of the origin of the Gospels, the diminished historical value which it is found necessary to ascribe to the Acts of the Apostles, the dubious character of the later Epistles ascribed to St. Paul, and the greater clearness of the circumstances under which the Apocalypse was composed—we must pass on to the investigations into the structure of the early Christian Churches and their theological ideas, especially those relating to the Eucharist, and we must also take in the change which has come about in the treatment of all early documents—that which teaches us to value them as literature, not as the quarry from which dogmatic statements may be hewed out. 3. Turning to the conditions of church-life we shall have to notice the abolition or mitigation of tests and subscriptions, and the greater tolerance and friendliness between those who hold different opinions or belong to different religious bodies; the freedom which the law of the Church, as interpreted by the Privy Council, gives to theological opinions of clergymen; together with the tendency, to which all religious bodies have been subject for some time past, to make less of abstract theological statements and more of practical piety and philanthropy. 4. Lastly, turning to the social and political conditions, we must consider the effect of our greater acquaintance with the wants of the masses, and the admission of the demand for equality. Theology has to take account not of a mere mass of ignorance and sin, but of human beings standing in moral equality with their teachers, and capable of virtue and self-direction, who require to be told, not, after the manner which reminds them of the older political economy, of a way of salvation under which a few elect souls may be saved, but, in a manner corresponding with the better social policy, how they may be helped to rise in all respects and all together.

Before going more into detail and showing the necessary or probable effects of these conditions upon theology, there are three remarks which should be made:

First, in the present day every institution is passing through the ordeal of criticism, and lives only because it can justify its existence. It would be foolish, if it were possible, to attempt the exemption of the study of theology from this process. Nor is there any reason why it should shrink from the questioning, if only it be applied with the patience and care which are necessary in dealing with an abstract subject, and one which touches men's inmost susceptibilities. This patience is required alike from those who are irritated by the old usurpations of theology, and would not be sorry if it could be banished altogether, and from those who esteem theology as the venerable mother and head of the sciences, and fear lest her majesty should be disparaged by too unabashed a gaze.

Secondly, it is neither honest nor politic to hide the real state of things. The questions which it suggests are felt not only by theologians, but by many thoughtful ministers and laymen; and we need not doubt that they are honestly met and solved in many cases. But the impression on the mind of the laity is that a hard system of dogmas which they have identified with "the gospel" exists unmodified in the mind of the clergy, and that theologians are quite unaware of the change which modern conditions have imposed upon religious thought. For instance, Professor Huxley, some years ago, when asked to give an address to the London clergy, proved in an elaborate exposition that the world was more than six thousand years old. Probably there was hardly one of his hearers, even at that time, who needed to be convinced of it. But theologians must feel that it is not mere personal and esoteric conviction, but a frank acknowledgment of the conditions of things, which is needed for the vindication of the dignity of their science and of their own intelligence and veracity.

Thirdly, it is not to be supposed, as sometimes happens, that those who subject an institution to such an ordeal are detracting from it. Criticism is not necessarily negative. More than thirty years ago Prince Albert said that constitutional government was on its trial, at a time when it hardly existed in any great European country but England. The trial it underwent was so successful that it is now recognized, more or less, as the form of government in all Europe, except Russia and Turkey. Criticism, moreover, even where barely negative, is often the means of purging away the dross and making the metal appear in its purity. Theology at the Christian era and at the Reformation underwent such a purification, and stood forth afterward far stronger and more fit for the purposes of piety. We must get down, at whatever expense, to the solid rock, and then we can safely build; but the tower we build will be nobler and more useful, because it stands firm. We need have no fear as to the future of theology and of the religious life which is founded upon it.

I.—1. To begin with the conditions imposed by the physical sciences. The immense advance which has been made in this department, alike in the way of discovery, of diffusion, and of application, is the most marked intellectual feature of our epoch. But physical science can not advance a step without the assumption of the uniformity of Nature. This uniformity is tested at every stage and never fails. The idea that it can fail becomes almost inconceivable. When the student turns to experience, he finds that violations of natural order which were supposed to take place in old times now take place no more; that no such violations can be found in times and places where they can be verified. Even in the sphere of Christian apologetics this is admitted more and more. The position of miracles has completely changed. They are no longer the basis of the argument, but are themselves the subject of apology. One accepted writer puts them in the fifth rank of evidences. Bishop Temple, in his "Bampton Lectures," shows by his treatment of them that they have lost their power. It is only the fact that they are supposed to be bound up with the moral and spiritual forces of Christianity which prevents their being treated as wholly indifferent.

We notice next the theory of evolution. Let it be granted that it is still a theory, and that the vast gaps in the geological record, and the chasm between man and brute, are not filled up. Yet the existence of evolution, in a constantly increasing circle of observed phenomena, is clear; and it would be perilous to rest any belief upon a supposition that the theory, even in its full compass, will be disproved. It is said that life must have had a beginning. Is it certain that life itself has not been developed, as some persons believe, or that the potency of life is not inherent in the elements of which the world is formed? The evidence may not at present point toward such a conclusion; but again it would be perilous to build upon the opposite theory. Indeed, the idea of creation must be admitted to be a negative rather than a positive idea. God made the world; but how? As soon as we attempt to put a positive sense into the word creation, it fails us. But what, it is asked, and where, is God, if he be not a creator? We must conceive of him otherwise than as a workman standing outside his work.

If we turn from the physical sciences to the science of language, which is said by Professor Max Müller to be itself a physical science, we are led up through comparative philology to comparative theology. The knowledge of the religions of the East and West shows us in their development points of the closest analogy with that recorded in the Bible, and the question is forced upon us whether there is any line to be drawn between them. Is not the idea of God in some of them both monotheistic and moral? If we fix our minds upon ideas once thought to be exclusively Christian, are there not incarnations and miraculous births and resurrections in the Brahmanical religion? Is there not the idea of self-sacrifice and of the equality of men in Buddhism? Does not Confucius come very near, to say the least, to the enunciation of the golden rule of the gospel? And has not this estimate of the Eastern religion so forced itself upon us that, whereas before the knowledge of the sacred books of the East missionaries were apt to speak only of the perishing heathen, and of their superstition and immorality, which were sinking them to perdition, now they speak rather of the hopeful side of their life, and apply the gospel as the means of evoking this into perfection? We evidently must not assert for Christianity an exclusive place in the upraising of the world to God.

2. Passing on to the sphere of criticism, we find that the Old Testament has undergone a great change. The successive labors of Ewald, Graf, and Wellhausen, in Germany; of Kuenen, in Holland; of Reuss among French, and Robertson Smith among English critics, have won the general assent of scholars—even of men of such conservative leanings as Delitzsch, in Germany; of Briggs, in America; and of the Oxford Hebraists, Driver and Cheyne. The "Guardian" newspaper, which represents the more educated opinion of the Anglican clergy, published, on the 3d of last November, a cautious article, from which we may infer its readiness to accept the results of this criticism, and its consciousness that Christian doctrine has nothing to fear from it. Let us endeavor to give a succinct account of these results.

The Pentateuch is now held to be of Mosaic origin only in the sense of incorporating historical and legal elements, which a tradition, partly but not wholly trustworthy, had handed down as connected with Moses. In its present state it consists mainly of three elements: 1. The early documents, which combine two sources, one of which uses the name Jehovah, the other Elohim; 2. The Deuteronomic; and, 3. The priestly: these three elements are represented in successive casts of the law by, 1. The Decalogue and the book of laws in Exodus xx–xxiii; 2. The Book of Deuteronomy; 3. The Book of Leviticus; and took shape in writings, the first about 800 B. C.; the second at the time of Manasseh or Josiah; the third during the period between Ezekiel and Ezra. In these three periods the early documents were successively rehandled, so that the first four books bear traces of the later influence, first of the Deuteronomist, and, secondly, of the Levitical writers; the Book of Joshua, also, has been subjected to the same processes, being, in fact, a continuation of the first five books, and forming with them the "Hexateuch." The histories, from Judges to 2 Kings, form a connected work, the various parts of which were composed at various times, some of them being contemporary with the events described, but which took its final shape in the time of Jeremiah. The Books of Chronicles, Ezra, and Nehemiah, form similarly one work, written under priestly influence long after the time of Ezra. The Book of Esther is a very late work, its claims to be placed in the Canon being disputed by the rabbis down to the Christian era. The Psalms are of many ages and authors, the Psalms actually written by David being limited to a very few, possibly to the eighteenth alone. The Proverbs belong to Solomon only in the sense in which the Psalms belong to David. Job is of quite uncertain date and origin, while Ecclesiastes belongs to the later Persian era, and the Song of Songs to the days of the northern kingdom. The Prophets remain as the solid center, their date beginning with the eighth century B. C., and the books being written by those whose names they bear, with the exception of Isaiah xl–xlvi, which belongs to the Babylonish captivity; of parts of Zechariah, which belong to several periods; and of the Book of Daniel, which is not properly to be numbered with the Prophets (the critics in this respect following the old Jewish estimate), but consists of a series of traditions put together for the encouragement of the faithful Jews in the time of the Maccabees.

In regard to the New Testament there is far less tendency to agreement among scholars. The researches relating to the Synoptic Gospels have made it clear that they are not independent accounts, but have a common origin either in an oral or a written tradition which was variously handled; that in all probability Mark was the oldest and Luke the latest of the three, but that the title "according to" St. Matthew or St. Mark permits of the hypothesis that they passed through a rehandling in a later generation of their disciples, and that the same is highly probable in the case of the fourth Gospel, which, however, many believe to have been wholly composed in the second century by some disciple or successor of St. John; that the Acts of the Apostles can not be wholly relied on for the details of the history; that the four great epistles of St. Paul are the earliest and most certain Christian documents; and that no reasonable doubt attaches to the Epistles to the Thessalonians. The Epistles of the Captivity present so different an aspect of Christianity that their actual Pauline authorship is the subject of some doubt, though from this doubt the Epistle to the Philippians is almost free; the pastoral Epistles, however, can not be treated with any certainty as having been written by St. Paul himself, and the Hebrews are almost certainly by another, though one in close sympathy with him. The Epistle of St. James is reckoned genuine; the Second Epistle of St. Peter and that of Jude are liable to the gravest doubts, and the First Epistle of Peter is not wholly undoubted. The Johannine epistles go with the fourth Gospel, and can hardly be by the same author as the Apocalypse, which is fixed almost without doubt to be the work of the apostle, and to have been written in the reign of the Emperor Galba.

It is, of course, quite possible that some of these opinions may be unsound. Few of them are wholly undisputed. It is possible also that the estimate here given of the tendency of opinion may not be entirely correct. Yet it can hardly be far from the truth; and the main lines of this criticism acquire a greater certainty and acceptance every year. In any case it has become impossible to deal with the sacred history as exempt from the conditions of ordinary history, or with the Psalms and prophets as if their glowing words could be taken as definitions of theological truths or rules of life. In the history we have to pick our way amid many doubtful paths, to ask at every turn whether the facts are exactly as they have been represented. Even in the didactic portions we have to inquire whether the sayings are genuine, and if so, to which of the various phases of a rapidly-changing development they belong. We have to admit the various tendencies in the teaching of the apostles ; and, in regard to the central figure of all, to gain from books subject to the same incidents as other forms of literature, and written by men who imperfectly understood him, our consciousness of the value of his life, his character, his teaching, and of his relation to mankind and to God.

The early history of the Church has likewise been subjected to a minute criticism, which has been stimulated of late by the discovery of the "Teaching of the Twelve Apostles." The result has been to give us a simpler view of the organization of the Christian societies and of their life and thoughts, to show the influence of various social circumstances working naturally upon them, and forming their institutions and their theology. It becomes less and less possible to attribute to the earliest period of the Church, as having been formally imposed or exclusively admitted, any of the theories of Church government which we now know, whether Episcopal, Presbyterian, or Independent, or the formed doctrines of later times, whether relating to the plan of redemption or to the Incarnation or the Trinity.

3. While the progress of science and criticism have thus made new conditions for theological thought, church-life has also undergone changes which allow of the necessary expansion. First, we must recall the formal liberation of opinion effected mainly by the judgment of the Privy Council, delivered in 1864, in the cases arising out of the "Essays and Reviews." The alarm excited ten years before by Mr. Maurice's theological essays, especially on the questions of the atonement and of eternal punishment, and by the works of Professor Jowett and Dr. Rowland Williams, found expression in Mr. Mansel's "Bampton Lectures" ; and when there appeared successively the first volume of Bishop Colenso's work on the Pentateuch, which was practically a polemic against verbal inspiration, and the "Essays and Reviews," which were a distinct demand for liberty of thought in the authorized teachers of the English Church, this alarm showed itself in the shape of prosecutions for heresy. Out of the multitude of statements impugned in the "Essays" of Dr. Williams and Mr. Wilson three only remained on which the Privy Council were called to adjudicate ; but they represented the three departments of theology on which liberty was most distinctly demanded : 1. The Atonement and Justification ; 2. The Inspiration of Scripture ; 3. Eternal Punishment. The charge relating to the first of these was withdrawn, and on the other two the judgment was in favor of the accused. Thus an almost complete liberty was won on the matters then under discussion, and the principles on which the judgment was based practically gave a similar assurance on other points. The tendency of the Privy Council, as representing the supremacy of the national over ecclesiastical law, has been almost uniformly in favor of liberty. It has been possible in a few extreme cases to procure the condemnation of cler-

gymen for matters of opinion; but these cases have been very rare, and the tendency to give liberty has been even-handed. The Gorham case gave a similar liberty to those who denied abnormal or supernatural power to one of the sacraments; the Bennett case gave liberty to those who asserted a similar power in the other. Even in cases of ritual, which stand on a different ground, being matters of formal regulation, there has been great unwillingness to press hardly on conscientious men, even when palpably defying the law; and the bishops have vindicated for themselves a power of stopping suits which they consider vexatious.

This action of the Privy Council corresponds with the general feeling. The different sections of the clergy and their adherents who made some outcry against the judgments, have gradually adopted more and more of the spirit of toleration which characterizes the law. To a large extent the judgments in doctrinal matters have preluded an actual change of opinion. The stringent doctrine of substitution as the essence of the atonement, the notion of inspiration as consisting in verbal accuracy rather than in the general spirit of the book, the belief in the everlasting perpetuation of sin and suffering, are alike strange to the present generation. They may still be held in some form, but probably in all cases with modifications, and they are certainly not insisted on as marks of true religion.

It may be partly the ill-success of past prosecutions for heresy, or it may be a consciousness that we are none of us in such literal conformity with the standards as to warrant us in casting stones at one another, or it may be some other consideration, which is the cause of the present aversion from an appeal to the courts. At all events, such an aversion exists. A striking proof of it has lately been furnished at Oxford. The rector of the City Church, Mr. Carteret Fletcher, was "delated" to the vice-chancellor for a sermon preached before the university, which contained the following passages:

1. Not long ago it was the general belief that man had been created perfect, but that he had fallen from perfection into an abyss of doom, whence only an elect fragment of the race would emerge; but it is now dawning on us that man was created in an undeveloped state, with a splendid potential wealth of faculty, and that he has advanced through long ages to his present stage, whence he is destined to rise higher than imagination can follow him. In him we see a rough-hewed block in course of being molded into perfect shape, and not the reconstruction of the shattered pieces of a faultless image.

2. The historical evidence of Christ's resurrection, after traversing a gulf of eighteen centuries, loses much of its convincing force in a scientific age which takes its stand on the uniformity of law. But this failing of the external evidence is more than compensated by our deeper realization of the inward proofs of human immortality; by our faith in the eternity of Christ's character, as well as by our consciousness of the high capacities and affections which he has called forth in us, and which are "mocked by the brevity of life, and are totally incapable of exhaustion here."

On these passages the accusation was grounded—1. That the preacher departed, and that knowingly, from the teaching of St. Paul on the fall of Adam. 2. That he denied the fact of the resurrection of our Lord. 3. That he claimed for the teachers of to-day to correct the teaching of the apostles, and of the Church on various other points.

It is true that three of the six doctors whom the vice-chancellor considered himself bound by the statute to appoint to inquire into the complaint could not bring themselves to pronounce Mr. Fletcher's teaching as free from the charge of being "dissonant or contrary to the doctrine of the Church of England as publicly received"; and that he was acquitted only by the casting vote of the vice-chancellor. But not only was the feeling of both residents and non-residents, of all shades of opinion, strongly adverse to the proceeding, but (we quote from the journal which represents the more conservative and clericalist side of university opinion) "an opinion to this effect was conveyed to Mr. Ffoulkes (the delator) in a letter signed by a number of those whose judgment might be supposed likely to have weight with him"; and it is added, "Mr. Ffoulkes's action is entirely his own." We may add that a certain sense of incongruity is imparted to the proceeding by the fact that Mr. Ffoulkes was himself for some time the holder of views within the Church of England which led him to become for some years a Roman Catholic. But the prevalent feeling has been that expressed by Trajan about persecution, "Non nostri sæculi est." As Mr. Fletcher says in the preface to his published sermon: "It is so incongruous with the ideas of our time that, even in serious people, it excites a sense of humor. It is like fighting with bows and arrows after the invention of cannon. Let us hope it will have the historical interest of being the last instance of its kind; the last flickering, expiring flame of a fire which once burned so fiercely, and nowhere more so than in Oxford." This feeling is shared by religious persons generally. It may rightly be said that almost any opinion, if put forward with sincere conviction and in a becoming spirit, will be allowed an unprejudiced hearing; and that, whether in the university or in the Church generally, prosecutions for matters of opinion are very unlikely to be repeated.

This conviction arises from the fact that this aversion from prosecution is not an isolated fact. It is connected with a spirit of tolerance which is wide-spread and well-grounded. Meetings like the Church Congress and the Diocesan Conferences have made the clergy and their adherents know and esteem one another, and Church parties have not the bitter antagonism they once had. In clerical circles this tolerance as yet hardly extends to Nonconformists; the clergy still to a great extent hold theories, and still more entertain exclusive feelings, which separate them and those attached to their teaching from co-operation in all spiritual things with dissenters. But there are exceptions to this which are becoming more frequent; personal esteem is often sincerely felt even where co-operation is refused, and co-operation is sometimes given in philanthropic schemes when refused in spiritual work. The free discussion of religion in the reviews and magazines and in private circles induces a still larger tolerance, so that even agnostics and positivists are not treated as outcasts by the most zealous of their Christian relations.

We must add to this the new state of things created by the modification of the tests imposed upon the clergy, and their abolition both in public life and at the universities. The clergy now profess only a general adherence to the formularies of worship, while in all other spheres tests are gone or doomed. This has tended to make religious profession more sincere, and to separate religion from injustice. It has also brought together those who would never have met. The presence even of one like Mr. Bradlaugh in Parliament is a preservative against conventionalism and hypocrisy when matters moral and religious are under debate. In the universities the fact that young men who are preparing for the ministry of various denominations, live together and share the same thoughts and associations, is pregnant with consequences to the future of church-life and of theology, as is also the freedom of speech and practice and the altered tone of religious instruction resulting from the presence of dissenters.

4. Theology can not separate itself from public life. The democratic and social uprising of our day must influence it. While a system of privilege was dominant in the state, it was natural perhaps to think of the few who were called, and to pass over the rest. The idea of men having no claim upon God, and of his relation to them as being either that of a vigorous upholder of law, or of one who only in certain cases and on certain terms showed favor to transgressors, was congenial to all to whom the chief political factors were the monarch and the upper classes, and the maintenance of a law in the making of which the mass of the subjects had had no hand. But the modern conviction that all men have their rights, and that the government exists for their sake, has communicated itself to theology. We can not think of men simply as offenders who need pardon; rather the fact that they have been created seems to give them a claim on their Creator. The mission and self-sacrifice of Christ seem an answer to this claim, and a promise of a better condition in this world as well as in the world to come. Nor is this only for individuals. The democracy moves in masses; we can not be content with the blessing of individuals as separate from their fellows, but must strive for the building up of the masses in true relations and brotherly equality.

Such appear to be the main conditions under which our theological beliefs are destined in future to move. We have now to consider what the movements of theology can be under these conditions.

II.—When the preacher whose words were quoted at the beginning of this article said that we must be Christian agnostics, he used the term agnostic not in the sense in which it is frequently used, and which implies, first, that it is more than doubtful whether the objects of theology exist at all; and, secondly, that it is a pestilent piece of folly to seek for any knowledge about them; but simply in the sense that they must be approached by other paths than those of a speculation which results in the formation of dogmas. The distinguished inventor of the name agnostic has in a recent number of this Review reminded us that "physical science is as little atheistic as it is materialistic." It may be as well to quote the passage ("Fortnightly Review" for December, 1886, page 799):

> The student of Nature who starts from the axiom of the universality of the law of causation, can not refuse to admit an eternal existence; if he admits the conservation of energy, he can not deny the possibility of an eternal energy; if he admits the existence of immaterial phenomena in the form of consciousness, he must admit the possibility at any rate of an eternal series of such phenomena; and, if his studies have not been barren of the best fruit of the investigation of Nature, he will have enough sense to see that, when Spinoza says, "Per Deum intelligo ens absolute infinitum, hoc est substantiam constantem infinitis attributis," the God so conceived is one that only a very great fool indeed would deny, even in his heart. Physical science is as little atheistic as it is materialistic.

Mr. Herbert Spencer goes further, and dwells upon this eternal energy as the mystery of mysteries, and considers that religion as maintaining the sense of this mystery is one of the most important factors of human life. We are all alike in the admission of a great object of thought to which the name of God has commonly been given. We have all to co-operate in the endeavor to estimate the nature and character of that object.

In the sermon above quoted it was pointed out that literature was one of the channels through which the great objects of theology would in future be approached. The preacher implied, like Mr. Matthew Arnold, that the literary conceptions of God and immortality ("words thrown out at a great subject," to use Mr. Arnold's expression) bring us nearer to the truth than dogmatic statements. It is not very different from what Aristotle says about morals "We must be content in such matters to exhibit the truth roughly and in a figure, and to reach our object by words which describe it in the general and to draw inferences of the same kind; for it is the mark of a man of culture to seek for exactness in each subject only so far as the nature of the thing admits. You do not expect exhortations from a mathematician or demonstration from a rhetorician." But theologians have commonly started in entire defiance of this warning. They have begun with axioms and definitions, and have proceeded to demonstrations. They have said or "proved" that God is just or good, God is personal, God is omniscient and omnipotent; and they have used these phrases not in a literary but a *quasi*-scientific manner, and have then proceeded to draw strict inferences from them. But in doing this they have not only acted in the way of unwarrantable assumption: they have often produced what St. Paul termed the vain janglings of a science falsely so called, have enslaved the Divine to their own puny conceptions, and have provoked violent revolt.

Suppose that a similar process had been applied to the greatest of moral powers, that of love. Suppose that men had upheld the importance of love by saying love is supreme, spontaneous, disinterested, and had written treatises to "prove" these statements, and had made deductions from them with little aid from experience; suppose that others had contradicted some of these statements and deductions, saying that love depends upon circumstances, upon juxtaposition, or upon prudential considerations, and that we have power over it, that it is a duty. Then suppose that each side had invoked poetry, proverbs, or historical records to "prove" his own theory, and had insisted that every verse or line that was quoted involved a certain proposition or dogma about love, and that, unless such a proposition was admitted, neither thought nor feeling nor action in the subject had any meaning or validity, so that the only question was which theory was correct. Suppose, further, that a physicist came in among them and said: "All this is quite unreal; love is a function of the bodily organization, and depends upon age and health, upon the state of the nerves, the heart, and the liver"; should we think that any of these processes was reasonable, or that any of them exalted our estimate of love? Should we not sweep them all away, and welcome one bright saying, one little idyl, one embrace, as having more meaning and bringing us more to the root of the matter than all of them?

In religious matters abstract reasoning is not our best mode of reaching truth. The objects we are dealing with are too great and too distant. We approach them from various sides, and say what we can and what appears true; but it is often by metaphor, and parable, and poetry, and by the experience which gives us the actual dealings of God with men rather than by direct statements, that we can perceive and convey to others any theological truth. This does not imply that we abandon a constructive theology, but that we must so speak as not to narrow down the true sense of the divine which we wish to receive and impart, that we must take account of all the conditions, that we must constantly appeal to experience; and, lastly, that the systems which we form must be understood to be a response to the intellectual need of our own day, necessarily imperfect, and always liable to revision.

1. As regards God. Instead of asserting *a priori*, or taking ready-made from the Scriptures abstract statements, such as those alluded to above, theologians must accept as their task the attempt to give a true account of the totality of things which is also a unity impelled by a

single power or energy. They will show the traces of order, mind, and purpose which the world presents, and will cautiously draw from the processes of human life as that which is highest in the moral scale their inferences as to the nature of the Supreme Power. They will not merely be careful not to contravene the laws of Nature, but will consider essential a knowledge of them as manifestations of the Supreme Will, to which men must reverently submit themselves. They will not spend time in questions which admit of no solution, such as the eternity of matter or the origin of the world, or the possibilities of other spheres of life than those known to us by experience. They will trace the divine as working through Nature and man ; or, if they endeavor to think of a transcendental God, they will take care not to represent him as a demiurge standing outside his work and putting in his hand here and there, a conception which has turned so many physicists into atheists. But they will feel able to speak of God as just and loving, since the Supreme Power *ex hypothesi* includes mankind, the leading portion of the world, with all its noblest ideals. They need not quarrel with those who think of the Supreme Power rather after the analogy of force or law than according to the strict idea of personality, provided that the moral nature of man be held fast and its supremacy acknowledged.

2. As regards the Scriptures. The theologian of our new epoch will start without any theory of inspiration. He will be ready to admit that God has revealed himself in part in other systems, ancient and modern. He will not pretend that the Scriptures are absolutely perfect in any part, but will take them for what they are really worth, and as constituting a history and a literature in which the development of religion is to be studied. But the fact that the Bible can not be used as the infallible mine of ready-made statements concerning history and morals, will throw him back from the letter to the spirit, from the external proof to the truth which is gained by thought and prayer ; while the development of religion described in Scripture, which even now stands forth in clear outline, will be found to be unique in its variety and completeness, and at the same time a type of the development of religion generally. The beauty and harmony of the whole, and the moral elevation of special parts, will gain by this natural treatment, as well as by comparison with other sacred books ; and the study will become more attractive, more inspiring, and more capable of giving strength and consolation.

3. As to the nature of Christ. Putting aside the long controversies which began in the third century, the theologian will be content to exhibit him as he really was, and then to trace and estimate the power which his life and spirit have exerted over mankind. The fact that he takes human nature as the chief guide to the divine, and does not pretend to an absolute knowledge of God, will give a new and peculiar interest to the study of the life and influence of Christ. It

will make men much more cautious in framing dogmas about his divinity; but experience in the future as in the past can but increase the sense of his moral supremacy, and the power of his life and death. And it is supremacy, not exclusiveness, which must be vindicated for the whole Christian system. These two terms, supremacy and exclusiveness, may be taken as marking the contrast between the position of Christianity under the new and under the old conditions.

4. As to miracles. It is evident that the arguments relied on in the last century do not help us now. We see that they imported the idea of a violation of the order of Nature into a time when no such notion as the order of Nature existed; that they assumed an exactness of observation and description in the narrators which our knowledge of the times and the documents forbids us to assume; and further that they dwelt on the mere physical process, while to the writers it is a part of the "many good works shown them from the Father," or the "signs of the kingdom of heaven." The theologian of the future will probably be little concerned with them. We have all learned to read in a natural sense the account of the crossing of the Red Sea, which even Mr. M. Arnold, some years ago, took as meant to record a violation of physical order. The strong east wind; the cloud which beat in the faces of the Egyptians, but by its lightning showed the Israelites their way; the waters kept back at low tide by the east wind, and walling in the course of the fugitives, but returning upon their pursuers when the tide rose and the eye of God looked forth upon them through the cloud in the morning, lose nothing in majesty or in providential importance when we read them without importing violations of the laws of Nature. And so it will be in many other cases; while as to those which are notable only for their strangeness, the action of hyperbole and the growth of the wonderful by tradition will be always present to the mind of the theologian, and will make him pass over them "with a light foot." We have no difficulty when we read of the miracles of St. Bernard or the prophecies of Savonarola, nor do they interfere with our estimate of those great men. The miracles of healing in the Gospel will, we can hardly doubt, always appear as evidence of a peculiar condition of human life in the East in the first century, and of the restorative power of a great personality. Little stress will be laid on the accounts of the infancy of Christ, since they are mentioned nowhere in the New Testament, outside the first chapters of the first and third Gospels. The case of the resurrection is quite different, since it passed immediately into the Christian consciousness. But the theologian who starts from the Epistles of St. Paul as the solid central ground of New Testament literature, will go upon the apostle's teaching that not flesh and blood, but the spiritual personality—clothed in the new house which is from heaven—inherits the kingdom of God, and will take the vision by which the apostle was converted as the type of all the manifestations by which the companions of Christ were

assured that he was not lost but gone before. He will, with St. Paul, take the assurance that Christ was alive after his passion as the fulfillment of the general hope of immortality which Israel had long entertained.

This hope of immortality was grounded on the connection of man with God, and espacially with his moral nature; and consequently, after the confirmation it received by the assurance of Christ's resurrection, it became a kind of passionate certitude. The history of the Church, however, shows how such a passion may become a great danger and source of corruption; and we may expect that the theologians of the future will substitute the "words thrown out at a great subject" for the certitude and definitions of the past. Immortality will be to them a great background of hope beyond the scene of present duty.

5. The theology of sin and redemption. This is the department of theology in which a kind of ideal dogmatism has most interfered with truth. The ideal characters of the wicked and the just, as they are described in Scripture, have been taken as literally existing; and, since men can not be ranked with the ideally righteous, they have been taken in the mass as belonging to the ideally wicked. Each action has been regarded as a conscious and open-eyed contradiction of a revealed standard of right, a contradiction which is described in the Gospel as a sin against the Holy Ghost. The false judgments, the mutual condemnations, the hypocrisy, the strange theories of redemption, the readiness to believe in eternal torments, the ascetic practices and unreal life which have resulted from this, could hardly be traced out in a lifetime. The reconstruction which will be required will need great labor. But in no department will the results be more fruitful. They will bring theological ethics into closer alliance with general science and practice. They will enable Christian teachers to treat all men as brothers, and make Christianity the means by which the state of men generally may be ameliorated.

6. The notion of the Church, the study of Church history, and the practice of church-life will be profoundly modified when once men realize that the Church is not necessarily a society held apart from the rest of mankind by having different pursuits as its object, and a peculiar form of government enjoined upon it. The Church will be simply that section of mankind in which the Christian spirit reigns; its history will be the history of the working out of the Divine principle in human society, with all its blessed results. The Church of the future will make its worship bear upon the higher ends of life; or, rather, it will teach that the true ritual is a holy life in all its departments, and thus it will merge itself more and more in general society, being ready, in the true spirit of its Lord, to lose itself that it may save mankind.

If we ask, in conclusion, what the prospects are as to the actual coming in of this better theology, there are three things which may enable us to answer hopefully.

First, the tolerance, which has been mentioned as one of the conditions under which we live, makes the path smooth before us. That which some have dignified by the name of "The New Reformation" has, we may hope, passed its stage of contention. The facts and views which have been set forth in this paper are not opposed by any solid array of party opinion, but rather find men in all parties who admit them. The ground, therefore, has been cleared, and the building has to be erected. The chief point on which our energies must be expended is Church history. This study, in its larger sense, embraces almost the whole field. The study of Scripture itself is mainly the study of the historical development by which the Church was prepared and founded. The study of dogma can not be profitable unless its history be known, and its various phases taken in combination with the circumstances of the time. And the knowledge of the progress made in the past is the surest guide for the future. History, therefore, is the frame in which all theological study must be set; and the knowledge of facts, their co-ordination and their significance, is that to which all theological students must turn their attention. We need not give up the hope of a full Christian philosophy, nor delay taking the initial steps toward it. But at every turn we are dependent on a knowledge of the path, which is as yet but imperfectly explored.

It may be asked, secondly, whether the introduction of these views will demand any great alteration in the formularies and practices of the Church. It is, indeed, desirable to give liberty, since tender consciences are fettered by any sense of bondage; and irritation, or needless pain, or incapacity, or in some cases hypocrisy, are the result. The clergy should not be required to make any subscription at all, but should simply be subject to the law of the system under which they serve. In the Church services some greater facilities for substitution and omissions would be desirable under the sanction of a competent local authority; and a document like the Athanasian Creed, which, where intelligible, recalls the age of controversies and condemnations, should not be read in the public services. But the chief adaptations of the old to the new must be made by thoughtful men for themselves; and the key to them will be found by going below the letter and seizing upon the real meaning of the assertions made, and translating them into practice. If the divinity of Christ is identified with his moral supremacy as a spiritual power; if the atonement means to us self-sacrifice, and faith a confidence in the divine righteousness; if absolution is the authoritative assurance of God's forgiveness; if election is the endowment of a few to be the leaders of the rest in Christian devotion, we shall not find any great difficulty in the language of the prayers and the other formularies in any of the Christian denominations.

Lastly, it is quite possible that much which is a puzzle to one generation will not be so to the next. It was often asked twenty years ago what would become of faith when men no longer believed the Bible to be infallible, and what of morality when they ceased to believe in eternal torments. But those who are now growing to maturity seem to find no lack of grounds for belief or of sanctions for practice. And the next generation may find no difficulty in the conditions of theological thought described in the first half of this article. The claims of Christian piety are strong, and the simplest doctrines are its best support. Duty, philanthropy, love, social and political improvement earnestly prosecuted in the fear of God and in the spirit of Christ, are independent of the ideas of dogmatic theology, and often unconscious of its changes.—*Fortnightly Review.*

# ASTRONOMY WITH AN OPERA-GLASS.

## THE STARS OF SUMMER.

By GARRETT P. SERVISS.

A SINGULAR proof of popular ignorance of the starry heavens, as well as of popular curiosity concerning any uncommon celestial phenomenon, is furnished by the curious notions prevailing about the planet Venus. When Venus began to attract general attention in the western sky in the early evening some two months ago, speculation quickly became rife about it, particularly on the great Brooklyn Bridge. As the planet hung dazzlingly bright over the New Jersey horizon, some people appeared to think it was the light of Liberty's torch, mistaking the bronze goddess's real flambeau for a part of the electric-light system of the metropolis. Finally (to judge from the letters written to the newspapers, and the questions asked of individuals supposed to know something about the secrets of the sky), the conviction seems to have become pretty widely distributed that the strange light in the west was no less than an electrically illuminated balloon, nightly sent skyward by Mr. Edison, for no other conceivable reason than a wizardly desire to mystify his fellow-men. I have positive information that this ridiculous notion has been actually entertained by more than one person of intelligence. And it is not improbable, that as Venus glows with increasing splendor in the serene evenings of June, she will continue to be mistaken for some petty artificial light instead of the magnificent world that she is, sparkling out there in the sunshine like a globe of burnished silver. Yet Venus as an evening star is not so rare a phenomenon that people of intelligence should be surprised at it. Once in every 584 days she reappears in the sunset sky—

> "Gem of the crimson-colored even,
> Companion of retiring day."

No eye can fail to note her, and as the nearest and most beautiful of the Earth's sisters it would seem that everybody should be as familiar with her appearance as with the face of a friend. But the popular ignorance of Venus, and the other members of the planetary family to which our mother, the Earth, belongs, is only an index of the denser ignorance concerning the stars—the brothers of our great father, the Sun. I believe this ignorance is largely due to mere indifference, which, in its turn, arises from a false and pedantic method of presenting astronomy as a jumble of mathematical formulæ, and a humble handmaiden of the art of navigation. Some teachers of astronomy are so fearful that their imagination may run away with them in the boundless fields of the universe, that they hobble it with a chain of ephemerides, break its jaw with a logarithmic bit, and end by earning what they, perhaps unconsciously, seek, a niche in the temple of Dry-as-dust. Of course, the public looks upon such things with indifference. Understand, I do not mean to cast doubt upon the scientific value of technical work in astronomy. The science could not exist without it. And no reproach is intended to those who have made the spectroscope reveal the composition of the sun and stars, and who are now making photography picture the heavens as they are, and even reveal phenomena which lie beyond the range of human vision. These are the men who have taken astronomy out of its swaddling-clothes, and set it on its feet as a progressive science. But when one sees the depressing and repellent effect that has evidently been produced upon the popular mind by the ordinary methods of presenting astronomy, one can not resist the temptation to utter a vigorous protest, and to declare that this glorious science is not the grinning mathematical skeleton that it has been represented to be.

Whoever will use an opera-glass, or even his naked eyes, with intelligence, in surveying the heavens, will quickly convince himself that all of astronomy is not embraced in the "Nautical Almanac."

In the April number of "The Popular Science Monthly" I pointed out some of the most interesting objects to be seen among the stars that adorn the sky in spring. The annual revolution of the heavens has now carried those stars that in April shone in the western sky below the horizon, while the constellations that were then in the east have now climbed to the zenith, or passed over to the west, and a fresh set of stars has taken their place in the east. In the present article we shall deal with what may be called the stars of summer; and, in order to furnish occupation for the observer with an opera-glass throughout the summer months, I have endeavored to so choose the constellations in which our explorations will be made, that some of them shall be favorably situated in each of the months of June, July, and August. The circular map represents the heavens at midnight on the 1st of June; at eleven o'clock, on the 15th of June; at ten o'clock, on the 1st of July; at nine o'clock, on the 15th of July; and at eight o'clock, on the 1st of August. Remembering that the center of the map is the point over his head, and that the edge of it represents the circle of the horizon, the reader, by a little attention and comparison with the sky, will be able to fix in his mind the relative situation of the

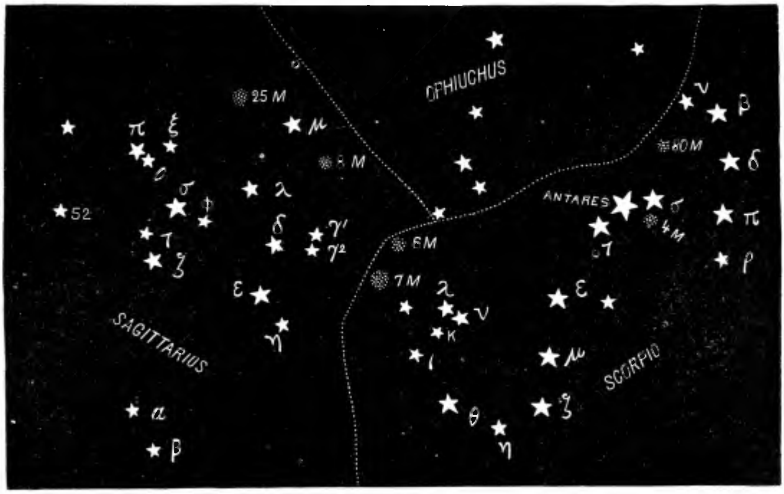

various constellations. The maps that follow will show him these constellations on a larger scale, and give him the names of their chief stars.

The observer need not wait until midnight on the 1st of June in order to find some of the constellations included in our map. Earlier in the evening, at about that date, say at nine o'clock, he will be able to see many of these constellations, but he must look for them farther toward the east than they are represented in the map. The bright stars in Boötes and Virgo, for instance, instead of being over in the southwest, as in the map, will be near the meridian; while Lyra, instead of shining high overhead, will be found climbing up out of the northeast. It would be well to begin at nine o'clock, about the 1st of June, and watch the motion of the heavens for two or three hours. At the commencement of the observations you will find the stars in Boötes, Virgo, and Lyra in the positions I have just mentioned, while half-way down the western sky will be seen the Sickle of Leo (see "Popular Science Monthly" for April). The brilliant Procyon and Capella will be found almost ready to set in the west and northwest, respectively. Between Procyon and Capella, and higher above the horizon, shine the twin stars in Gemini, with the planets Venus and Saturn, near each other, below them. There will be no difficulty in recognizing Venus, for it is now brighter than any other star in the heavens. Saturn would be regarded also as a very bright star, but for the overpowering contrast with its more brilliant sister. Looking over into the south, the observer will see the planet Jupiter a little east of Spica in Virgo, and second only to Venus in brilliancy.

In an hour Saturn and Venus will be setting, and Jupiter will be well past the meridian. In another hour the observer will perceive that the constellations are approaching the places given to them in our map, and at midnight he will find them all in their assigned positions. A single evening spent in observations of this sort will teach him more about the places of the stars than he could learn from a dozen books.

Taking, now, the largest opera-glass you can get (I have before said that the diameter of the object-glasses should not be less than 1·5 inch, and, I may add, the larger they are the better), find the constellation Scorpio, and its chief star Antares. The map shows you where to look for it at midnight on the 1st of June. If you prefer to begin at nine o'clock at that date, then, instead of looking directly in the south for Scorpio, you must expect to see it just rising in the southeast. You will recognize Antares by its fiery color, as well as by the striking arrangement of its surrounding stars. There are few constellations which bear so close a resemblance to the objects they are named after as Scorpio. It does not require a very violent exercise of the imagination to see in this long, winding trail of stars a gigantic scorpion, with its head to the west, and flourishing its upraised sting that glitters with a pair of twin stars, as if ready to strike. Readers of the old story of Phaeton's disastrous attempt to drive the chariot of the Sun for a day will remember it was the sight of this threatening monster that so terrified the ambitious youth that he lost control of Apollo's horses, and came near burning the earth up by running the Sun into it.

Antares rather gains in redness when viewed with a glass. Its color is very remarkable, and it is a curious circumstance that with powerful telescopes a small, bright-green star is seen apparently almost touching it. Antares belongs to Secchi's third type of suns, that in which the spectroscopic appearances suggest the existence of a powerful absorptive atmosphere, and which are believed on various grounds to be, as Lockyer has said, "in the last visible stage of cooling"; in other words, almost extinct. This great, red star probably in actual size exceeds our sun, and no one can help feeling the sublime nature of those studies which give us reason to think that here we can




SCORPIO AND SAGITTARIUS.

actually behold almost the expiring throes of a giant brother of our giant Sun. Only, the lifetime of a sun is many millions of years, and its gradual extinction, even after it has reached a stage as advanced as that of Antares is supposed to be, may occupy a longer time than the whole duration of the human race.

The opera-glass will show a number of faint stars scattered around Antares. Turn now to Beta ($\beta$) in Scorpio, with the glass. A very pretty pair of stars will be seen hanging below $\beta$. Sweeping downward from this point to the horizon you will find many beautiful star-fields. The star marked Nu ($\nu$) is a double which you will be able to separate with a powerful field-glass, the distance between its components being 40″.

And next let us look at a star-cluster. You will see on the map an object marked 4 M., near Antares. Its designation means that it is No. 4 in Messier's catalogue of nebulæ. It is not a true nebula, but a closely compacted cluster of stars. With the opera-glass, if you are looking in a clear and moonless night, you will see it as a curious nebulous speck. With a field-glass its real nature is more apparent, and it is seen to blaze brighter toward the center. It is, in fact, one of those universes within the universe where thousands of suns are associated together by some unknown law of aggregation into assemblages of whose splendor the slight view that we can get gives us but the faintest conception.

The object above and to the left of Antares, marked in the map 80 M., is a nebula, and although the nebula itself is too small to be seen with an opera-glass (a field-glass shows it as a mere wisp of light), yet there is a pretty array of small stars in its neighborhood worth looking at. Besides, this nebula is of special interest, because in 1860 a star suddenly took its place. At least, that is what seemed to have happened. What really did occur, probably, was that a variable or temporary star, situated between us and the nebula, and ordinarily too faint to be perceived, received a sudden and enormous accession of light, and blazed up so brightly as to blot out of sight the faint nebula behind it. If this star should make its appearance again, it could easily be seen with an opera-glass, and so it will not be useless for the reader to know where to look for it. The quarter of the heavens with which we are now dealing is famous for these celestial conflagrations, if so they may be called.

We shall presently see some examples of star-clusters and nebulæ with which the instruments we are using are better capable of dealing. In the mean time, let us follow the bending row of stars from Antares toward the south and east. When you reach the star Mu ($\mu$), you are not unlikely to stop with an exclamation of admiration, for the glass will separate it into two stars that, shining side by side, seem trying to rival each other in brightness. But the next star below $\mu$, marked Zeta ($\zeta$), is even more beautiful. It also separates into two stars, one being reddish and the other bluish in color. The contrast in a clear night is very pleasing. But this is not all. Above the two stars you will notice a curious nebulous speck. Now, if you have a powerful field-glass, here is an opportunity to view one of the prettiest sights in the heavens. The field-glass not only makes the two stars appear brighter, and their colors more pronounced, but it shows a third, fainter star below them, making a small triangle, and brings other still fainter stars into sight, while the nebulous speck above turns into a charmingly beautiful little star-cluster, whose components are so close that their rays are inextricably mingled in a maze of light. This little cut is an attempt to represent the scene, but no engraving can reproduce the life and sparkle of it.

ZETA SCORPIONIS.

Following the bend of the Scorpion's tail upward, we come to the pair of stars in the sting. These, of course, are thrown wide apart by the opera-glass. Then let us sweep off to the eastward a little way and find the cluster known as 7 M. You will see it marked on the map. Above it, and near enough to be included in the same field of view, is 6 M., a smaller cluster. Both of these have a sparkling appearance with an opera-glass, and by close attention some of the separate stars in 7 M. may be detected. With a field-glass these clusters become much more striking and starry looking, and the curious radiated structure of 7 M. comes out.

In looking at such objects we can not too often recall to our minds the significance of what we see—that these glimmering specks are the lights in the windows of the universe which carry to us, across inconceivable tracts of space, the assurance that we and our little system are not alone in the heavens ; that all around us, and even on the very confines of immensity, Nature is busy, as she is here, and the laws of light, heat, gravitation (and why not of life ?) are in full activity.

The clusters we have just been looking at lie on the borders of Scorpio and Sagittarius. Let us cross over into the latter constellation, which commemorates the centaur Chiron. We are now in another, and even a richer, region of wonders. The Milky-Way, streaming down out of the northeast, pours, in a luminous flood through Sagittarius, inundating that whole region of the heavens with seeming deeps and shallows, and finally bursting the barriers of the horizon disappears, only to glow with redoubled splendor in the southern hemisphere. The stars Zeta ($\zeta$), Tau ($\tau$), Sigma ($\sigma$), Phi ($\phi$), Lambda ($\lambda$), and Mu ($\mu$) indicate the outlines of a figure sometimes called the Milk-Dipper, which is very evident when the eye has once recognized it. On either side of the upturned handle of this dipper-like figure lie some of the most interesting objects in the sky. Let us take the star $\mu$ for a starting-point. Sweep downward and to the right a little way, and you will be startled by a most singular phenomenon that has suddenly made its appearance in the field of view of your glass. You may, perhaps, be tempted to congratulate yourself on having got ahead of all the astronomers, and discovered a comet. It is really a combination of a star-cluster with a nebula, and is known as 8 M. Sir John Herschel has described the "nebulous folds and masses" and dark oval gaps which he saw in this nebula with his large telescope at the Cape of Good Hope. But no telescope is needed to make it appear a wonderful object; an opera-glass suffices for that, and a field-glass reveals still more of its marvelous structure.

On the opposite side of the star $\mu$—that is to say, above and a little to the left—is an entirely different but almost equally attractive spectacle, the swarm of stars called 24 M. Here, again, the field-glass easily shows its superiority over the opera-glass, for magnifying power is needed to bring out the innumerable little twinklers of which the cluster is composed. But, whether you use an opera-glass or a field-glass, do not fail to gaze long and steadily at this island of stars, for much of its beauty becomes evident only after the eye has accustomed itself to disentangle the glimmering rays with which the whole field of view is filled. Try the method of averted vision, and hundreds of the finest conceivable points of light will seem to spring into view out of the depths of the sky. The necessity of a perfectly clear night, and the absence of moonlight, can not be too much insisted upon for observations such as these. Everybody knows how the moonlight blots out the smaller stars. A slight haziness, or smoke, in the air produces a similar effect. It is as important to the observer with an opera-glass to have a transparent atmosphere as it is to one who would use a telescope; but, fortunately, the work of the former is not so much interfered with by currents of air. Always avoid the neighborhood of any bright light. Electric lights in particular are an abomination to star-gazers.

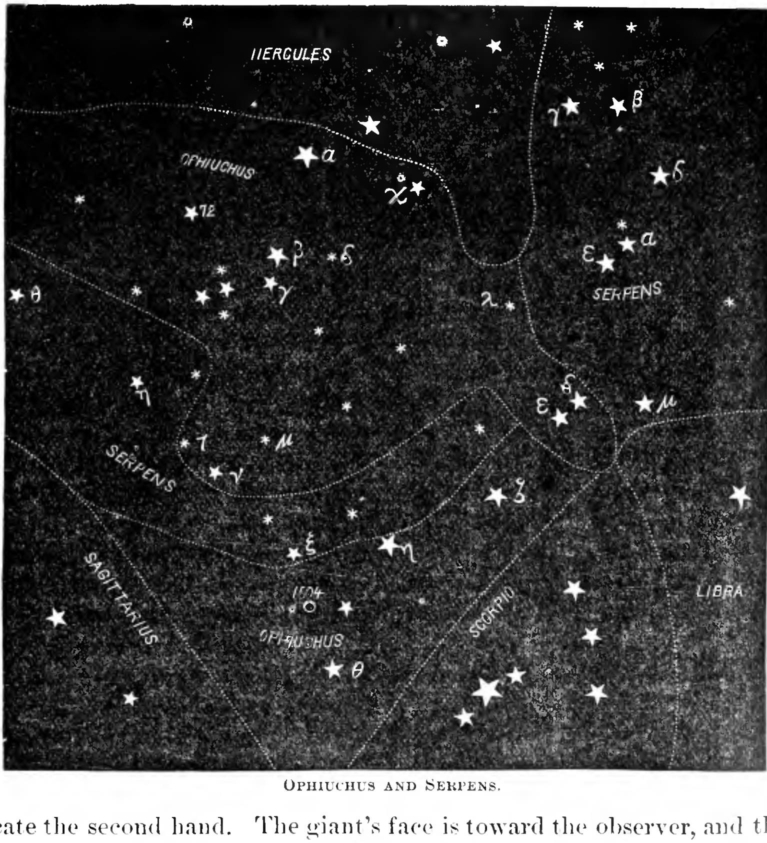
The cloud of stars we have just been looking at is in a very rich region of the Milky-Way, in the little modern constellation called "Sobieski's Shield," which we have not placed upon our map. Sweeping slowly upward from 24 M. a little way with the field-glass, we will pass in succession over three nebulous-looking spots. The second of these, counting upward, is the famous Horseshoe nebula. Its wonders are beyond the reach of our instrument, but its place may be recognized. Look carefully all around this region, and you will perceive that the old gods, who traveled this road (the Milky-Way was sometimes called the pathway of the gods), trod upon golden sands. Off a little way to the east you will find the rich cluster called 25 M. But do not imagine the thousands of stars that your opera-glass or field-glass reveals comprise all the riches of this Golconda of the heavens. You might ply the powers of the greatest telescope in a vain attempt to exhaust its wealth. As a hint of the wonders that lie hidden here, let me quote Father Secchi's description of a starry spot in this same neighborhood, viewed with the great telescope at Rome. After telling of "beds of stars superposed upon one another," and of the wonderful geometrical arrangement of the larger stars visible in the field, he adds:

"The greater number are arranged in spiral arcs, in which one can count as many as ten or twelve stars of the ninth to the tenth magnitude following one another in a curve, like beads upon a string. Sometimes they form rays which seem to diverge from a common focus, and, what is very singular, one usually finds, either at the center of the rays, or at the beginning of the curve, a more brilliant star of a red color, which seems to lead the march. It is impossible to believe that such an arrangement can be accidental."

The reader will recall the somewhat similar description that Admiral Smyth and Mr. Webb have given of a star-cluster in Gemini (see "Popular Science Monthly" for April).

The groups of stars forming the eastern half of the constellation of Sagittarius are worth sweeping over with the glass, as a number of pretty pairs may be found there.

Next let us pass to the double constellation adjoining Scorpio and Sagittarius on the north—Ophiuchus and the Serpent. These constellations, as our map shows, are curiously intermixed. The imagination of the old star-gazers, who named them, saw here the figure of a giant grasping a writhing serpent with his hands. The head of the serpent is under the Northern Crown, and its tail ends over the star-gemmed region that we have just described, called "Sobieski's Shield." Ophiuchus stands, as figured in Flamsteed's "Atlas," upon the back of the Scorpion, holding the serpent with one hand below the neck, this hand being indicated by the pair of stars marked Epsilon ($\epsilon$) and Delta ($\delta$), and with the other near the tail. The stars Tau ($\tau$) and Nu ($\nu$) indi-




OPHIUCHUS AND SERPENS.

cate the second hand. The giant's face is toward the observer, and the star Alpha ($\alpha$), also called Ras Alhague, shines in his forehead, while Beta ($\beta$) and Gamma ($\gamma$) mark his right shoulder. Ophiuchus has been held to represent the famous physician Æsculapius. One may well repress the tendency to smile at these fanciful legends when he reflects upon their antiquity. There is no doubt that this double constellation is at least three thousand years old—that is to say, for thirty centuries the imagination of men has continued to shape these stars into the figures of a gigantic man struggling with a huge serpent. If it possesses no other interest, then it at least has that which attaches to all things ancient. Like many other of the constellations it has proved longer-lived than the mightiest nations. While Greece flourished and decayed, while Rome rose and fell, while the scepter of civilization has passed from race to race, these starry creations of fancy have shone on unchanged. The mind that would ignore them now deserves compassion.

The reader will observe a little circle in the map, and near it the figures 1604. This indicates the spot where one of the most famous temporary stars on record appeared in the year 1604. At first it was far brighter than any other star in the heavens; but it quickly faded, and in a little over a year disappeared. It is particularly interesting, because Kepler—the quaintest, and not far from the greatest, figure in astronomical history—wrote a curious book about it. Some of the philosophers of the day argued that the sudden outburst of the wonderful star was caused by the chance meeting of atoms. Kepler's reply was characteristic, as well as amusing:

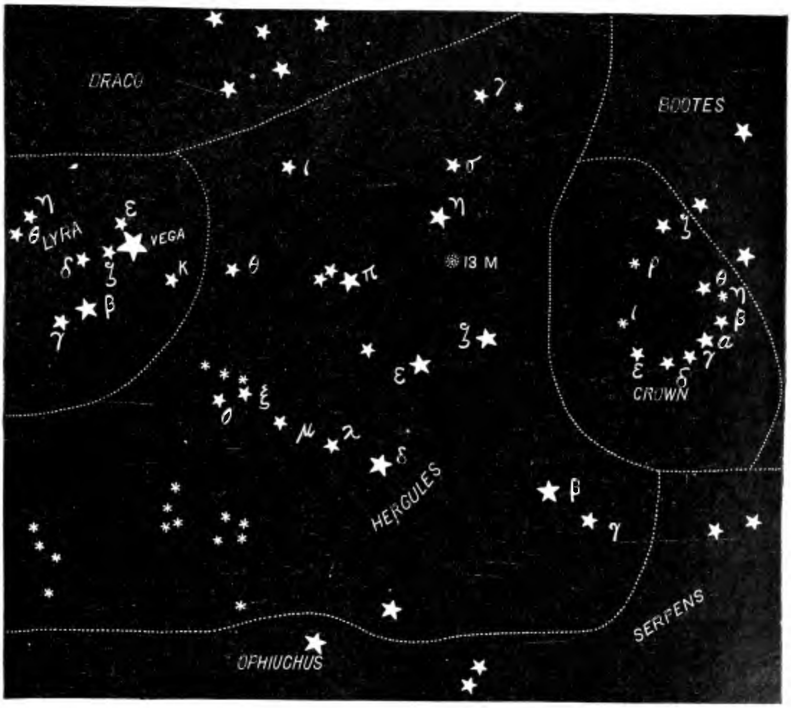
"I will tell those disputants, my opponents, not my own opinion, but my wife's. Yesterday, when I was weary with writing, my mind being quite dusty with considering these atoms, I was called to supper, and a salad I had asked for was set before me. 'It seems, then,' said I, aloud, 'that if pewter dishes, leaves of lettuce, grains of salt, drops of water, vinegar and oil, and slices of egg, had been flying about in the air from all eternity, it might at last happen by chance that there would come a salad.' 'Yes,' says my wife, 'but not so nice and well-dressed as this of mine is.'"

While there are no objects of special interest for the observer with an opera-glass in Ophiuchus, he will find it worth while to sweep over it for what he may pick up, and, in particular, he should look at the group of stars southeast of $\beta$ and $\gamma$. These stars have been shaped into a little modern asterism called Taurus Poniatowskii, and it will be noticed that five of them mark the outlines of a letter V, resembling the well-known figure of the Hyades.

Also look at the stars in the head of Serpens, several of which form a figure like a letter X. A little west of Theta ($\theta$), in the tail of Serpens, is a beautiful swarm of little stars, upon which a field-glass may be used with advantage. The star $\theta$ is itself a beautiful double, just within the separating power of a very powerful field-glass under favorable circumstances, the component stars being only about one third of a minute apart.

Do not fail to notice the remarkable subdivisions of the Milky-Way in this neighborhood. Its current seems divided into numerous channels and bays, interspersed with gaps that might be likened to islands, and the star $\theta$ appears to be situated upon one of these islands of the galaxy. This complicated structure of the Milky-Way extends downward to the horizon, and upward through the constellation Cygnus, and of its phenomenal appearance in that region we shall have more to say farther on.

Directly north of Ophiuchus is the constellation Hercules, interesting as occupying that part of the heavens toward which the proper motion of the sun in space is bearing the earth and its fellow planets, at the rate, probably, of not less than 160,000,000 miles in a year—a stupendous voyage through space, of whose destination we are as ignorant as the crew of a ship sailing under sealed orders, and, like whom, we must depend upon such inferences as we can draw from courses and distances, for no other information comes to us from the flag-ship of our squadron.




Hercules, Lyra, and the Northern Crown.

In the accompanying map we have represented the beautiful constellations Lyra and the Northern Crown, lying on either side of Hercules. The reader should note that the point overhead in this map is not far from the star Eta ($\eta$) in Hercules. The bottom of the map is toward the south, the right-hand side is west, and the left-hand side east. It is important to keep these directions in mind, in comparing the map with the sky. For instance, the observer must not expect to look into the south and see Hercules half-way up the sky, with Lyra a little east of it ; he must look for Hercules nearly overhead, and Lyra a little east of the zenith. The same precautions are not necessary in using the maps of Scorpio, Sagittarius, and Ophiuchus, because those constellations are nearer the horizon, and so the observer does not have to imagine the map as being suspended over his head.

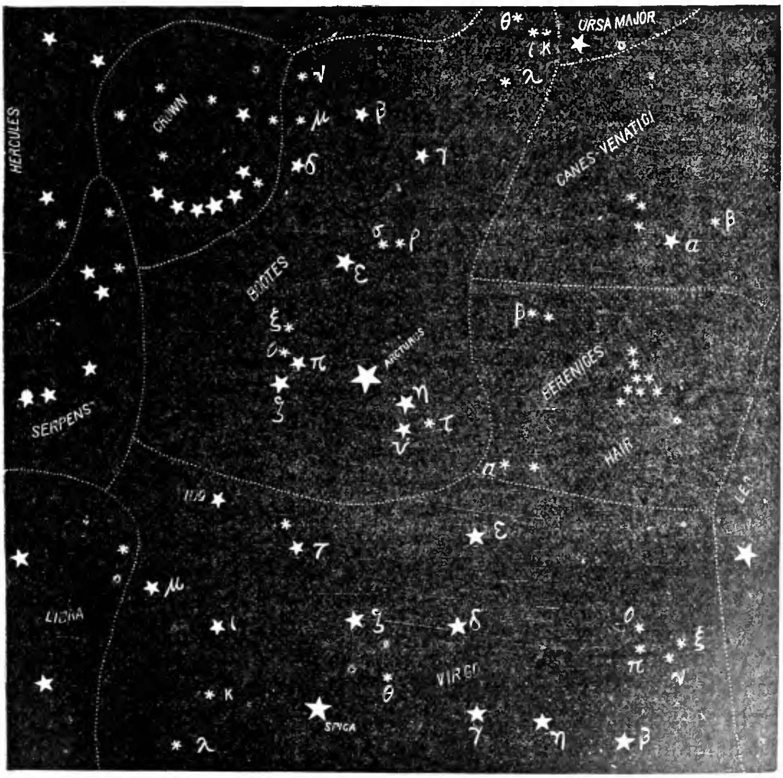
The name Hercules sufficiently indicates the mythological origin of the constellation, and yet the Greeks did not know it by that name, for Aratus calls it "the Phantom whose name none can tell." The Northern Crown, according to fable, was the celebrated crown of Ariadne, and Lyra was the harp of Orpheus himself.

With the aid of the map you will be able to recognize the principal stars and star-groups in Hercules, and will find many interesting combinations of stars for yourself. An object of special interest is the celebrated star-cluster 13 M. You will find it on the map between the stars Eta ($\eta$) and Zeta ($\zeta$). While an opera-glass will only show it as a faint and minute speck, lying nearly between two little stars, it is nevertheless well worth looking for, on account of the great renown of this wonderful congregation of stars. Sir William Herschel computed the number of stars contained in it as about fourteen thousand. It is roughly spherical in shape, though there are many straggling stars around it evidently connected with the cluster. In short, it is *a ball of suns.* The reader should not mistake what that implies, however. These suns, though truly solar bodies, are probably very much smaller than our sun. Mr. Gore has recently computed their average diameter to be about forty-five thousand miles, and the distance separating one from another to be 9,000,000,000 miles. Adopting Mr. Gore's estimates of their size and distance, I have recently shown, in a newspaper article, that, as seen from the center of the cluster, the nearest stars would shine about fourteen hundred times as bright as Sirius, while even the farthest stars in the cluster would be much brighter than Sirius, so that a world situated there would enjoy a sort of perpetual daylight, the illumination of its nocturnal sky being, perhaps, as much as fifteen times greater than the light shed from the full moon upon the earth.

If you have a field-glass, by all means try it upon 13 M. It will give you a more satisfactory view than an opera-glass is capable of doing, and will magnify the cluster so that there can be no possibility of mistaking it for a star. Compare this compact cluster, which only a powerful telescope can partially resolve into its component stars, with 7 M. and 24 M., described above, in order to comprehend the wide variety in the structure of these aggregations of stars.

The Northern Crown, although a strikingly beautiful constellation to the naked eye, offers few attractions to the opera-glass. Let us turn, then, to Lyra. I have never been able to make up my mind which of three great stars is entitled to precedence—Vega, the leading brilliant of Lyra, Arcturus in Boötes, or Capella in Auriga. They are the three leaders of the northern firmament, but which of them should be called the chief, is very hard to say. At any rate, Vega would probably be generally regarded as the most beautiful, on account of the delicate bluish tinge in its light, especially when viewed with a glass. There is no possibility of mistaking this star on account of its surprising brilliancy. Two faint stars close to Vega on the east make a beautiful little triangle with it, and thus form a further means of recognition, if any were needed. Your opera-glass will show that the floor of heaven is powdered with stars, fine as the dust of a diamond, all around the neighborhood of Vega, and the longer you gaze the more of these diminutive twinklers you will discover.

Now direct your glass to the northernmost of the two little stars near Vega, the one marked Epsilon (ε) in the map. You will perceive that it is composed of two stars of almost equal magnitude. If you had a telescope of considerable power, you would find that each of these stars is in turn double. In other words, this wonderful star which appears single to the unassisted eye, is in reality quadruple, and there is reason to think that the four stars composing it are connected in pairs, the members of each pair revolving around their common cen-




VIRGO AND BOÖTES.

ter while the two pairs in turn circle around a center common to all. With a field-glass you will be able to see that the other star near Vega, Zeta (ζ), is also double, the distance between its components being three quarters of a minute, while the two stars in ε are a little less than $3\frac{1}{2}'$. The star Beta ($\beta$) is remarkably variable in brightness. You may watch these variations, which run through a regular period of about 12 days, $21\frac{3}{4}$ hours, for yourself. The star will be at its minimum of brightness on June 7th and 20th; July 3d, 15th, and 28th; August 10th and 23d. Between Beta and Gamma ($\gamma$) lies the beautiful Ring nebula, but it is hopelessly beyond the reach of the optical means we are employing.

Let us turn next to the stars in the west. In consulting the accompanying map of Virgo and Boötes, the observer is supposed to face the southwest, at the hours and dates mentioned above as those to which the circular map corresponds. He will then see the bright star Spica in Virgo not far above the horizon, while Arcturus will be half-way up the sky, and the Northern Crown will be near the zenith. The planet Jupiter will be close to Spica, and will completely outshine it. In fact, during the whole summer, this fine star will be to a considerable extent robbed of its brilliance by the proximity of the great planet. The reader may find it convenient to mark the place of Jupiter on the map just to the left of Spica.

The constellation Virgo is an interesting one in mythological story. Aratus tells us that the Virgin's home was once on earth, where she bore the name of Justice and in the golden age all men obeyed her. In the silver age her visits to men became less frequent, "no longer finding the spirits of former days"; and, finally, when the brazen age came with the clangor of war:

> "Justice, loathing that race of men,
> Winged her flight to heaven; and fixed
> Her station in that region
> Where still by night is seen
> The Virgin goddess near to bright Boötes."

The chief star of Virgo, Spica, is remarkable for its pure white light. To my eye there is no conspicuous star in the sky equal to it in this respect, and it gains in beauty when viewed with a glass. With the aid of the map the reader will find the celebrated binary star Gamma ($\gamma$) Virginis, although he will not be able to separate its components without a telescope. It is a curious fact that the star Epsilon ($\epsilon$) in Virgo has for many ages been known as the Grape-Gatherer. It has borne this name in Greek, in Latin, in Persian, and in Arabic, the origin of the appellation undoubtedly being that it was observed to rise just before the sun in the season of the vintage. It will be observed that the stars $\epsilon$, $\delta$, $\gamma$, $\eta$, and $\beta$, mark two sides of a quadrilateral figure of which the opposite corner is indicated by Denebola in the tail of Leo. Within this quadrilateral lies the marvelous Field of the Nebulæ, a region where with adequate optical power one may find hundreds of these strange objects thronging together, a very storehouse of the germs of suns and worlds. Unfortunately, these nebulæ are far beyond the reach of an opera-glass, but it is worth while to know where this curious region is, even if we can not behold the wonders it contains. The stars Omicron ($o$), Pi ($\pi$), etc., forming a little group, mark the head of Virgo.

The constellation Libra, lying between Virgo and Scorpio, does not contain much to attract our attention. Its two chief stars, $\alpha$ and $\beta$, may be readily recognized west of and above the head of Scorpio. The upper one of the two, $\beta$, has a singular greenish tint, and the lower one, $\alpha$, is a very pretty double for an opera-glass.

BERENICE'S HAIR.

Just north of Virgo's head will be seen the glimmering of Berenice's Hair. This little constellation was included among those described in the article on "The Stars of Spring," but it is worth looking at again in the early summer, on moonless nights, and we give here a picture of its stars as seen with a good glass. The singular arrangement of the brighter members of the cluster at once strikes the eye.

Boötes, whose leading brilliant, Arcturus, occupies the center of our map, also possesses a curious mythical history. It was called by the Greeks the Bear-Driver, because it seems continually to chase Ursa Major, the Great Bear, in his path around the pole. The story is that Boötes was the son of the nymph Calisto, whom Juno in one of her customary fits of jealousy turned into a bear. Boötes, who had become a famous hunter, one day roused a bear from her lair, and not knowing that it was his mother, was about to kill her, when Jupiter came to the rescue and snatched them both up into the sky, where they have shone ever since. How this story remained in men's minds is shown by Lucan's reference to it when, describing Brutus's visit to Cato at night, he fixes the time by the position of these constellations in the heavens :

> "'Twas when the solemn dead of night came on,
> When bright Calisto, with her shining son,
> Now half the circle round the pole had run."

Boötes is not specially interesting for our purposes, except for the splendor of Arcturus. This star has possessed a peculiar charm for me ever since boyhood, when, having read a description of it in an old treatise on Uranography I felt an eager desire to see it. As my search for it chanced to begin at a season when Arcturus did not rise till after a boy's bed-time, I was for a long time disappointed, and I shall never forget the start of surprise and almost of awe with which I finally caught sight of it, one spring evening, shooting its flaming rays through the boughs of an apple-orchard, like a star on fire.

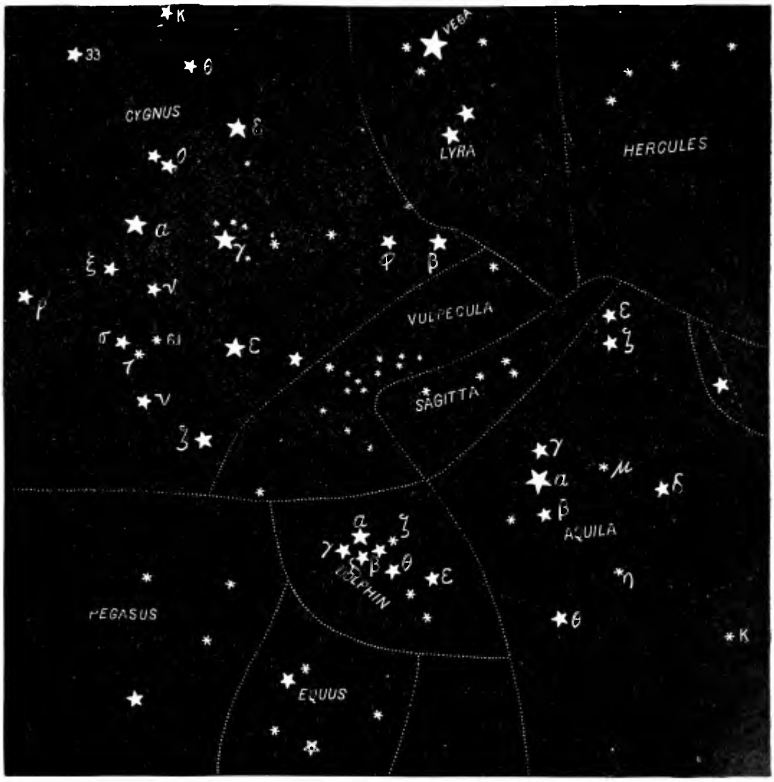
When near the horizon, Arcturus has a remarkably reddish color; but, after it has attained a high elevation in the sky, it appears rather a deep yellow than red. There is a scattered cluster of small stars surrounding Arcturus, forming an admirable spectacle with an opera-glass on a clear night. To see these stars well, the glass should be slowly moved about. Many of them are hidden by the glare of Arcturus. The little group of stars near the handle of the end of the Great Dipper, or, what is the same thing, the tail of the Great Bear, marks the upraised hand of Boötes. Between Berenice's Hair and the tail of the Bear you will see a small constellation called Canes Venatici, the Hunting-Dogs. On the old star-maps Boötes is represented as holding these dogs with a leash, while they are straining in chase of the Bear. You will find some pretty groupings of stars in this constellation.

And now we will turn to the east. Our next map shows Cygnus, a constellation especially remarkable for the large and striking figure that it contains, called the Northern Cross, Aquila the Eagle, the Dolphin, and the little asterisms Sagitta and Vulpecula. In consulting the map, the observer is supposed to face toward the east. In Aquila the curious arrangement of two stars on either side of the chief star of the constellation, called Altair, at once attracts the eye. Within a circle including the two attendants of Altair you will probably be able to see with the naked eye only two or three stars in addition to the three large ones. Now turn your glass upon the same spot, and you will see eight or ten times as many stars, and with a field-glass still more can be seen. Watch the star marked Eta ($\eta$), and you will find that its light is variable, being sometimes more than twice as bright as at other times. Its changes are periodical, and occupy a little over a week.

This Eagle is fabled to have been the bird that Jupiter kept beside his throne. A constellation called Antinous, invented by Tycho Brahe, is represented on some maps as occupying the lower portion of the space given to Aquila.

The Dolphin is an interesting little constellation, and the ancients said it represented the very animal on whose back the famous musician Arion rode through the sea after his escape from the sailors who tried to murder him. But some modern has dubbed it with the less romantic name of Job's Coffin, by which it is sometimes called. It presents a very pretty sight to the opera-glass.

Cygnus, the Swan, is a constellation whose mythological history is somewhat obscure, although, as remarked above, it contains one of the most clearly marked figures to be found among the stars, the famous Northern Cross. The outlines of this cross are marked with great distinctness by the stars Alpha ($\alpha$), Epsilon ($\epsilon$), Gamma ($\gamma$), Delta ($\delta$), and Beta ($\beta$), together with some fainter stars lying along the main beam of the cross between $\beta$ and $\gamma$. The star $\beta$, also called Albireo, is one of the most beautiful double stars in the heavens. The components are sharply contrasted in color, the larger star being golden-




CYGNUS, AQUILA, THE DOLPHIN, ETC.

yellow, while the smaller one is a deep, rich blue. With a field-glass of 1·6-inch aperture and magnifying full six times I have sometimes been able to divide this pair, and to recognize the blue color of the smaller star. It will be found a severe test for such a glass.

About half way from Albireo to the two stars $\zeta$ and $\epsilon$ in Aquila, is a very curious little group consisting of six or seven stars in a straight row, with a garland of other stars hanging from the center. To see it best, take a field-glass, although an opera-glass shows it.

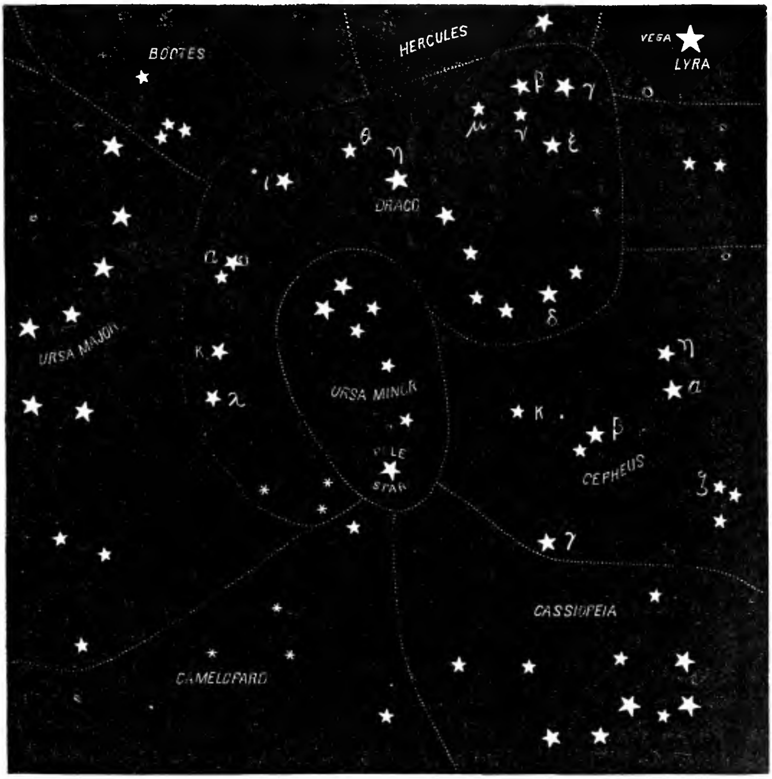
I have indicated the place of the celebrated star 61 Cygni in the map, because of the interest attaching to it as the nearest to us, so far as we know, of all the stars in the northern hemisphere, and with one exception the nearest star in all the heavens. Yet it is very faint, and the fact that so inconspicuous a star should be nearer than such brilliants as Vega and Arcturus shows how wide is the range of magnitude among the suns that light the universe. The actual distance of 61 Cygni is something like 650,000 times as great as the distance from the earth to the sun.

The star Omicron ($o$) is very interesting with an opera-glass. The naked eye sees a little star near it. The glass throws them wide apart, and divides $o$ itself into two stars. Now, a field-glass, if of sufficient power, will divide the larger of these stars again into two—a fine test.

Sweep around $\alpha$ and $\gamma$ for the splendid star-fields that abound in this neighborhood; also around the upper part of the figure of the cross. We are here in one of the richest parts of the Milky-Way. Between the stars $\alpha$, $\gamma$, $\epsilon$, is the strange dark gap in the galaxy called the Coal-Sack, a sort of hole in the starry heavens. Although it is not entirely empty of stars, its blackness is striking in contrast with the brilliancy of the Milky-Way in this neighborhood. The divergent streams of the great river of light in this region present a very remarkable appearance.

Finally, we come to the great dragon of the sky. In using the map of Draco and the neighboring constellations, the reader is supposed to face the north. The upper edge of the center of the map is directly over the observer's head. One of the stories told of this large constellation is that it represents a dragon that had the temerity to war against Minerva. The goddess "seized it in her hand, and hurled it, twisted as it was, into the heavens round the axis of the world, before it had time to unwind its contortions." Others say it is the dragon that guarded the golden apples in the Garden of the Hesperides, and that was slain by the redoubtable Hercules. At any rate, it is plainly a monster of the first magnitude. The stars $\beta$, $\gamma$, $\xi$, $\nu$, and $\mu$ represent its head, while its body runs trailing along, first sweeping in a long curve toward Cepheus, and then bending around and passing between the two bears. Try $\nu$ with your opera-glass, and if you succeed in seeing it double you may congratulate yourself on your keen sight. The distance between the stars is about 1′. Notice the contrasted colors of $\gamma$ and $\beta$, the former being a rich orange and the latter white. As you sweep along the winding way that Draco follows, you will run across many striking fields of stars, although the heavens are not as rich here as in the splendid regions that we have just left. You will also find that Cepheus, although not an attractive constellation to the naked eye, is worth some attention with an opera-glass. It, however, sinks into insignificance in comparison with its neighbor Cassiopeia, but that constellation belongs rather to the autumn sky, and we shall pass it by here.

The reader will find it both interesting and instructive to watch the movements of Venus through the summer. On June 1st as we have seen, Venus will be near Saturn in the constellation Gemini. But the two planets will rapidly part company, Saturn sinking toward the horizon day by day until it is no longer seen, while Venus, moving eastwardly, rises higher every evening. About the middle of July, Venus, having reached her greatest eastern elongation, will turn upon




Draco and its Neighbors.

her track and move westwardly, setting a little earlier every night. At the middle of August she will attain her greatest brilliancy, and will be a superb phenomenon. Being then in that part of her orbit which passes between the earth and the sun, her illuminated disk will be in the form of a crescent. A good field-glass, under favorable circumstances, will show this crescent form of Venus, and a most beautiful sight it is. The crescent will grow larger and narrower in proportion as Venus approaches nearer to the line joining the earth and the sun, and, as she approaches that line, of course she will draw closer to the horizon, until about the end of August, she disappears from the evening sky, to reappear in the east as a morning-star in the autumn.

Jupiter will remain in the neighborhood of Spica in Virgo throughout the summer. The surface features of this majestic planet are far beyond the reach of an opera- or field-glass, but some of the members of his little family of four moons may occasionally be caught sight of. With an opera-glass not more than one or two of these can be seen as excessively minute dots of light half-hidden in the glare of the planet. If you succeed under favorable circumstances in seeing one of these moons with your glass, you will be all the more astonished to learn that there are several apparently well-authenticated instances of one of the moons of Jupiter having been seen with the naked eye.

JUPITER AND HIS MOONS. (Seen with a field-glass; power, six diameters.)

With a field-glass, however, you will have no difficulty in seeing all of the moons when they are properly situated. If you miss one or more of them, you may know that it is either between you and the planet, or behind the planet, or buried in the planet's shadow, or else so close to the planet as to be concealed by its radiance. For the convenience of the beginner, I will indicate the positions of Jupiter's moons for several evenings in June, based upon the "Nautical Almanac" predictions; the time of observation is supposed to be 10.30 o'clock P. M.:

On June 1st all four satellites will be visible with a good field-glass, one being on the eastern and the other three on the western side of the planet, two of the latter appearing close together like a double star.

On June 2d the satellites will all be on the western side, two of them being pretty close to the planet and also close together, while the others are more distant and wide apart.

On June 6th all four will be on the eastern side of Jupiter, and three of them, besides being near the planet, will be close together in a slanting row. It will require close watching with a fine glass to see them all, but the spectacle will be well worth some painstaking on the part of the observer.

On June 8th two will be on one side and two on the other, the two on the west being close together, while those on the east are widely separated.

On June 14th two will be close together on the east, while one is visible on the west, and the fourth, the outermost of the system, is passing just above the north pole of the planet, and so close that it will probably be beyond the ability even of a powerful field-glass to detect it.

On June 17th there will be a very good opportunity for the inexperienced observer to see all four of the satellites, as two will be on each side of the planet and all will be well separated.

On June 22d one satellite will be on the east of Jupiter, and the other three on the west, all in a bunch, and close to the planet.

Of course, since the motions of the satellites, particularly of the inner ones, are very rapid, their positions are continually changing, and their configurations are different every night. I have merely indicated their places for a few evenings, in order that the observer may be able to recognize the satellites when he sees them. If he has any doubt about his identification of them, or thinks they may be little stars, he has only to carefully note their position and then look at them again the next evening. He may even notice their motion in the course of a single evening, if he begins early and follows them for three or four hours.

## SCIENCE AND PSEUDO-SCIENCE.

By Professor T. H. HUXLEY.

IN the opening sentences of a contribution to the last number of this Review, the Duke of Argyll has favored me with a lecture on the proprieties of controversy, to which I should be disposed to listen with more docility if his Grace's precepts appeared to me to be based upon rational principles, or if his example were more exemplary.

With respect to the latter point, the duke has thought fit to entitle his article "Professor Huxley on Canon Liddon," and thus forces into prominence an element of personality which those who read the paper which is the object of the duke's animadversions will observe I have endeavored, most carefully, to avoid. My criticisms dealt with a report of a sermon, published in a newspaper, and thereby addressed to all the world. Whether that sermon was preached by A or B was not a matter of the smallest consequence; and I went out of my way to absolve the learned divine to whom the discourse was attributed from the responsibility for statements which, for anything I knew to the contrary, might contain imperfect, or inaccurate, representations of his views. The assertion that I had the wish or was beset by any "temptation to attack" Canon Liddon is simply contrary to fact.

But suppose that if, instead of sedulously avoiding even the appearance of such attack, I had thought fit to take a different course; suppose that, after satisfying myself that the eminent clergyman whose name is paraded by the Duke of Argyll had really uttered the words attributed to him from the pulpit of St. Paul's, what right would any one have to find fault with my action on grounds either of justice, expediency, or good taste?

Establishment has its duties as well as its rights. The clergy of a state Church enjoy many advantages over those of unprivileged and unendowed religious persuasions, but they lie under a correlative responsibility to the state, and to every member of the body politic. I am not aware that any sacredness attaches to sermons. If preachers stray beyond the doctrinal limits set by lay lawyers, the Privy Council will see to it; and, if they think fit to use their pulpits for the promulgation of literary, or historical, or scientific errors, it is not only the right, but the duty, of the humblest layman, who may happen to be better informed, to correct the evil effects of such perversion of the opportunities which the state affords them and such misuse of the authority which its support lends them. Whatever else it may claim to be, in its relations with the state, the Established Church is a branch of the civil service; and, for those who repudiate the ecclesiastical authority of the clergy, they are merely civil servants, as much responsible to the English people for the proper performance of their duties as any others.

The Duke of Argyll tells us that the "work and calling" of the clergy prevent them from "pursuing disputation as others can." I wonder if his Grace ever reads the so-called religious newspapers? It is not an occupation which I should commend to any one who wishes to employ his time profitably; but a very short devotion to this exercise will suffice to convince him that the "pursuit of disputation," carried to a degree of acrimony and vehemence unsurpassed in lay controversies, seems to be found quite compatible with the "work and calling" of a remarkably large number of the clergy.

Finally, it appears to me that nothing can be in worse taste than the assumption that a body of English gentlemen can, by any possibility, desire that immunity from criticism which the Duke of Argyll claims for them. Nothing would be more personally offensive to me than the supposition that I shirked criticism, just or unjust, of any lecture I ever gave. I should be utterly ashamed of myself if, when I stood up as an instructor of others, I had not taken every pains to assure myself of the truth of that which I was about to say; and I should feel myself bound to be even more careful with a popular assembly, who would take me more or less on trust, than with an audience of competent and critical experts.

I decline to assume that the standard of morality, in these matters, is lower among the clergy than it is among scientific men. I refuse to think that the priest who stands up before a congregation as the minister and interpreter of the Divinity is less careful in his utterances, less ready to meet adverse comment, than the layman who comes before his audience as the minister and interpreter of Nature. Yet what should we think of the man of science who, when his ignorance or his carelessness was exposed, whined about the want of delicacy of his critics, or pleaded his "work and calling" as a reason for being let alone?

No man, nor any body of men, is good enough, or wise enough, to dispense with the tonic of criticism. Nothing has done more harm to the clergy than the practice, too common among laymen, of regarding them, when in the pulpit, as a sort of chartered libertines, whose divagations are not to be taken seriously. And I am well assured that the distinguished divine, to whom the sermon is attributed, is the last person who would desire to avail himself of the dishonoring protection which has been superfluously thrown over him.

So much for the lecture on propriety. But the Duke of Argyll, to whom the hortatory style seems to come naturally, does me the honor to make my sayings the subjects of a series of other admonitions, some on philosophical, some on geological, some on biological topics. I can but rejoice that the duke's authority in these matters is not always employed to show that I am ignorant of them; on the contrary, I meet with an amount of agreement, even of approbation, for which I proffer such gratitude as may be due, even if that gratitude is sometimes almost overshadowed by surprise.

I am unfeignedly astonished to find that the Duke of Argyll, who professes to intervene on behalf of the preacher, does really, like another Balaam, bless me altogether in respect of the main issue.

I denied the justice of the preacher's ascription to men of science of the doctrine that miracles are incredible, because they are violations of natural law; and the Duke of Argyll says that he believes my "denial to be well founded. The preacher was answering an objection which has now been generally abandoned." Either the preacher knew this or he did not know it. It seems to me, as a mere lay teacher, to be a pity that the "great dome of St. Paul's" should have been made to "echo" (if so be that such stentorian effects were really produced) a statement which, admitting the first alternative, was unfair, and, admitting the second, was ignorant.*

Having thus sacrificed one half of the preacher's arguments, the Duke of Argyll proceeds to make equally short work with the other half. It appears that he fully accepts my position that the occurrence of those events, which the preacher speaks of as catastrophes, is no evidence of disorder, inasmuch as such catastrophes may be necessary occasional consequences of uniform changes. Whence I conclude, his Grace agrees with me, that the talk about royal laws "wrecking" ordinary laws may be eloquent metaphor, but is also nonsense.

* The Duke of Argyll speaks of the recent date of the demonstration of the fallacy of the doctrine in question. "Recent" is a relative term, but I may mention that the question is fully discussed in my book on "Hume," which, if I may believe my publishers, has been read by a good many people since it appeared in 1879. Moreover, I observe, from a note at page 89 of "The Reign of Law," a work to which I shall have occasion to advert by-and-by, that the Duke of Argyll draws attention to the circumstance that, so long ago as 1866, the views which I hold on this subject were well known. The duke, in fact, writing about this time, says, after quoting a phrase of mine, "The question of miracles seems now to be admitted on all hands to be simply a question of evidence." In science we think that a teacher who ignores views which have been discussed *coram populo* for twenty years, is hardly up to the mark.

And now comes a further surprise. After having given these superfluous stabs to the slain body of the preacher's argument, my good ally remarks, with magnificent calmness, "So far, then, the preacher and the professor are at one. . . . Let them smoke the calumet." By all means: smoke would be the most appropriate symbol of this wonderful attempt to cover a retreat. After all, the duke has come to bury the preacher, not to praise him; only he makes the funeral obsequies look as much like a triumphal procession as possible.

So far as the questions between the preacher and myself are concerned, then, I may feel happy. The authority of the Duke of Argyll is ranged on my side. But the duke has raised a number of other questions, with respect to which I fear I shall have to dispense with his support—nay even be compelled to differ from him as much as or more than I have done about his Grace's new rendering of the "benefit of clergy."

In discussing catastrophes, the duke indulges in statements, partly scientific, partly anecdotic, which appear to me to be somewhat misleading. We are told, to begin with, that Sir Charles Lyell's doctrine respecting the proper mode of interpreting the facts of geology (which is commonly called uniformitarianism) "does not hold its head quite so high as it once did." That is great news indeed. But is it true? All I can say is that I am aware of nothing that has happened of late that can in any way justify it; and my opinion is, that the body of Lyell's doctrine, as laid down in that great work, "The Principles of Geology," whatever may have happened to its head, is a chief and permanent constituent of the foundations of geological science.

But this question can not be advantageously discussed, unless we take some pains to discriminate between the essential part of the uniformitarian doctrine and its accessories; and it does not appear that the Duke of Argyll has carried his studies of geological philosophy so far as this point. For he defines uniformitarianism to be the assumption of the "extreme slowness and perfect continuity of all geological changes."

What "perfect continuity" may mean in this definition, I am by no means sure; but I can only imagine that it signifies the absence of any break in the course of natural order during the millions of years, the lapse of which is recorded by geological phenomena.

Is the Duke of Argyll prepared to say that any geologist of authority, at the present day, believes that there is the slightest evidence of the occurrence of supernatural intervention, during the long ages of which the monuments are preserved to us in the crust of the earth? And if he is not, in what sense has this part of the uniformitarian doctrine, as he defines it, lowered its pretensions to represent scientific truth?

As to the "extreme slowness of all geological changes," it is simply a popular error to regard that as, in any wise, a fundamental and necessary dogma of uniformitarianism. It is extremely astonishing to me that any one who has carefully studied Lyell's great work can have so completely failed to appreciate its purport, which yet is "writ large" on the very title-page: "The Principles of Geology, being an Attempt to explain the Former Changes of the Earth's Surface by Reference to Causes now in Operation." The essence of Lyell's doctrine is here written so that those who run may read; and it has nothing to do with the quickness or slowness of the past changes of the earth's surface, except in so far as existing analogous changes may go on slowly, and therefore create a presumption in favor of the slowness of past changes.

With that epigrammatic force which characterizes his style, Buffon wrote, nearly a hundred and fifty years ago, in his famous "Théorie de la Terre," "Pour juger de ce qui est arrivé, et même de ce qui arrivera, nous n'avons qu'à examiner ce qui arrive." The key of the past, as of the future, is to be sought in the present, and only when known causes of change have been shown to be insufficient have we any right to have recourse to unknown causes. Geology is as much an historical science as archæology; and I apprehend that all sound historical investigation rests upon this axiom. It underlay all Hutton's work, and animated Lyell and Scrope in their successful efforts to revolutionize the geology of half a century ago.

There is no antagonism whatever, and there never was, between the belief in the views which had their chief and unwearied advocate in Lyell and the belief in the occurrence of catastrophes. The first edition of Lyell's "Principles," published in 1830, lies before me, and a large part of the first volume is occupied by an account of volcanic, seismic, and diluvial catastrophes which have occurred within the historical period. Moreover, the author over and over again expressly draws the attention of his readers to the consistency of catastrophes with his doctrine:

> Notwithstanding, therefore, that we have not witnessed within the last three thousand years the devastation by deluge of a large continent, yet, as we may predict the future occurrence of such catastrophes, we are authorized to regard them as part of the present order of Nature, and they may be introduced into geological speculations respecting the past, provided that we do not imagine them to have been more frequent or general than we expect them to be in time to come (vol. i, p. 89).

Again:

> If we regard each of the causes separately, which we know to be at present the most instrumental in remodeling the state of the surface, we shall find that we must expect each to be in action for thousands of years, without producing any extensive alterations in the habitable surface, and then to give rise, during a very brief period, to important revolutions (vol. ii, p. 161).*

* See also vol. i, p. 460. In the ninth edition (1853), published twenty-three years after the first, Lyell deprives even the most careless reader of any excuse for misunder-

Lyell quarreled with the catastrophists, then, by no means because they assumed that catastrophes occur and have occurred, but because they had got into the habit of calling on their god Catastrophe to help them when they ought to have been putting their shoulders to the wheel of observation of the present course of Nature, in order to help themselves out of their difficulties. And geological science has become what it is chiefly because geologists have gradually accepted Lyell's doctrine and followed his precepts.

So far as I know anything about the matter, there is nothing that can be called proof, that the causes of geological phenomena operated more intensely or more rapidly at any time between the older Tertiary and the oldest Palæozoic epochs than they have done between the older Tertiary epoch and the present day. And if that is so, uniformitarianism, even as limited by Lyell,* has no call to lower its crest. But, if the facts were otherwise, the position Lyell took up remains impregnable. He did not say that the geological operations of Nature were never more rapid, or more vast, than they are now; what he did maintain is the very different proposition that there is no good evidence of anything of the kind. And that proposition has not yet been shown to be incorrect.

I owe more than I can tell to the careful study of the "Principles of Geology" in my young days; and, long before the year 1856, my mind was familiar with the truth that "the doctrine of uniformity is not incompatible with great and sudden changes," which, as I have shown, is taught *totidem verbis* in that work. Even had it been possible for me to shut my eyes to the sense of what I had read in the "Principles," Whewell's "Philosophy of the Inductive Sciences," published in 1840, a work with which I was also tolerably familiar, must have opened them. For the always acute, if not always profound, author, in arguing against Lyell's uniformitarianism, expressly points out that it does not in any way contravene the occurrence of catastrophes.

standing him: "So in regard to subterranean movements, the theory of the perpetual uniformity of the force which they exert on the earth-crust is quite consistent with the admission of their alternate development and suspension for indefinite periods within limited geographical areas" (p. 187).

* A great many years ago ("Presidential Address to the Geological Society," 1869) I ventured to indicate that which seemed to me to be the weak point, not in the fundamental principles of uniformitarianism, but in uniformitarianism as taught by Lyell. It lay, to my mind, in the refusal by Hutton, and in a less degree by Lyell, to look beyond the limits of the time recorded by the stratified rocks. I said: "This attempt to limit, at a particular point, the progress of inductive and deductive reasoning from the things which are to the things which were—this faithlessness to its own logic—seems to me to have cost uniformitarianism the place as the permanent form of geological speculation which it might otherwise have held" ("Lay Sermons," p. 260). The context shows that "uniformitarianism" here means that doctrine, as limited in application by Hutton and Lyell, and that what I mean by "evolutionism" is consistent and thoroughgoing uniformitarianism.

With regard to such occurrences [earthquakes, deluges, etc.], terrible as they appear at the time, they may not much affect the average rate of change: there may be a *cycle*, though an irregular one, of rapid and slow change; and if such cycles go on succeeding each other, we may still call the order of Nature uniform, notwithstanding the periods of violence which it involves.*

The reader who has followed me through this brief chapter of the history of geological philosophy, will probably find the following passage in the paper of the Duke of Argyll to be not a little remarkable:

Many years ago, when I had the honor of being President of the British Association,† I ventured to point out, in the presence and in the hearing of that most distinguished man [Sir C. Lyell] that the doctrine of uniformity was not incompatible with great and sudden changes, since cycles of these and other cycles of comparative rest might well be constituent parts of that uniformity which he asserted. Lyell did not object to this extended interpretation of his own doctrine, and, indeed, expressed to me his entire concurrence.

I should think he did; for, as I have shown, there was nothing in it that Lyell himself had not said six-and-twenty years before, and enforced three years before; and it is almost verbally identical with the view of uniformitarianism taken by Whewell, sixteen years before, in a work with which one would think that any one who undertakes to discuss the philosophy of science should be familiar.

Thirty years have elapsed since the beginner of 1856 persuaded himself that he enlightened the foremost geologist of his time, and one of the most acute and far-seeing men of science of any time, as to the scope of the doctrines which the veteran philosopher had grown gray in promulgating; and the Duke of Argyll's acquaintance with the literature of geology has not, even now, become sufficiently profound to dissipate that pleasant delusion.

If the Duke of Argyll's guidance in that branch of physical science, with which alone he has given evidence of any practical acquaintance, is thus unsafe, I may breathe more freely in setting my opinion against the authoritative deliverances of his Grace about matters which lie outside the province of geology.

And here the duke's paper offers me such a wealth of opportunities that choice becomes embarrassing. I must bear in mind the good old adage "non multa sed multum." Tempting as it would be to follow the duke through his labyrinthine misunderstandings of the ordinary terminology of philosophy, and to comment on the curious unintelligibility which hangs about his frequent outpourings of fervid language, limits of space oblige me to restrict myself to those points, the discussion of which may help to enlighten the public in respect of matters of more importance than the competence of my Mentor for the task which he has undertaken.

I am not sure when the employment of the word Law, in the sense

* "Philosophy of the Inductive Sciences," vol. i, p. 670. New edition, 1847.

† At Glasgow in 1856.

in which we speak of laws of Nature, commenced, but examples of it may be found in the works of Bacon, Descartes, and Spinoza. Bacon employs "law" as the equivalent of "form," and I am inclined to think that he may be responsible for a good deal of the confusion that has subsequently arisen; but I am not aware that the term is used by other authorities, in the seventeenth and eighteenth centuries, in any other sense than that of "rule" or "definite order" of the coexistence of things or succession of events in Nature. Descartes speaks of "règles, que je nomme les lois de la nature." Leibnitz says "loi ou règle générale," as if he considered the terms interchangeable.

The Duke of Argyll, however, affirms that the "law of gravitation" as put forth by Newton was something more than the statement of an observed order. He admits that Kepler's three laws "were an observed order of facts and nothing more." As to the law of gravitation, "it contains an element which Kepler's laws did not contain, even an element of causation, the recognition of which belongs to a higher category of intellectual conceptions than that which is concerned in the mere observation and record of separate and apparently unconnected facts." There is hardly a line in these paragraphs which appears to me to be indisputable. But, to confine myself to the matter in hand, I can not conceive that any one who had taken ordinary pains to acquaint himself with the real nature of either Kepler's or Newton's work could have written them. That the labors of Kepler, of all men in the world, should be called "mere observation and record," is truly wonderful. And any one who will look into the "Principia," or the "Optics," or the "Letters to Bentley," will see, even if he has no more special knowledge of the topics discussed than I have, that Newton over and over again insisted that he had nothing to do with gravitation as a physical cause, and that when he used the terms attraction, force, and the like, he employed them, as he says, "*mathematicè*" and not "*physicè*."

How these attractions [of gravity, magnetism, and electricity] may be performed, I do not here consider. What I call attraction may be performed by impulse or by some other means unknown to me. I use that word here to signify only in a general way any force by which bodies tend toward one another, whatever be the cause.*

According to my reading of the best authorities upon the history of science, Newton discovered neither gravitation nor the law of gravitation; nor did he pretend to offer more than a conjecture as to the causation of gravitation. Moreover, his assertion that the notion of a body acting where it is not, is one that no competent thinker could entertain, is antagonistic to the whole current conception of attractive and repulsive forces, and therefore of "the attractive force of gravitation." What, then, was that labor of unsurpassed magnitude and excellence and immortal influence which Newton did perform?

* "Optics," query 31.

In the first place, Newton defined the laws, rules, or observed order of the phenomena of motion, which come under our daily observation, with greater precision than had been before attained ; and, by following out with marvelous power and subtilty the mathematical consequences of these rules, he almost created the modern science of pure mechanics. In the second place, applying exactly the same method to the explication of the facts of astronomy as that which was applied a century and a half later to the facts of geology by Lyell, he set himself to solve the following problem : Assuming that all bodies, free to move, tend to approach one another as the earth and the bodies on it do ; assuming that the strength of that tendency is directly as the mass and inversely as the squares of the distances ; assuming that the laws of motion, determined for terrestrial bodies, hold good throughout the universe ; assuming that the planets and their satellites were created and placed at their observed mean distances, and that each received a certain impulse from the Creator—will the form of the orbits, the varying rates of motion of the planets, and the ratio between those rates and their distances from the sun which must follow by mathematical reasoning from these premises, agree with the order of facts determined by Kepler and others, or not ?

Newton, employing mathematical methods which are the admiration of adepts, but which no one but himself appears to have been able to use with ease, not only answered this question in the affirmative, but stayed not his constructive genius before it had founded modern physical astronomy.

The historians of mechanical and of astronomical science appear to be agreed that he was the first person who clearly and distinctly put forth the hypothesis that the phenomena comprehended under the general name of "gravity" follow the same order throughout the universe, and that all material bodies exhibit these phenomena ; so that, in this sense, the idea of universal gravitation may, doubtless, be properly ascribed to him.

Newton proved that the laws of Kepler were particular consequences of the laws of motion and the law of gravitation—in other words, the reason of the first lay in the two latter. But to talk of the law of gravitation, alone, as the reason of Kepler's laws, and still more as standing in any causal relation to Kepler's laws, is simply a misuse of language. It would really be interesting if the Duke of Argyll would explain how he proposes to set about showing that the elliptical form of the orbits of the planets, the constant area described by the radius vector, and the proportionality of the squares of the periodic times to the cubes of the distances from the sun, are either caused by the "force of gravitation" or deducible from the "law of gravitation." I conceive that it would be about as apposite to say that the various compounds of nitrogen with oxygen are caused by chemical attraction and deducible from the atomic theory.

Newton assuredly lent no shadow of support to the modern pseudo-scientific philosophy which confounds laws with causes. I have not taken the trouble to trace out this commonest of fallacies to its first beginning; but I was familiar with it in full bloom, more than forty years ago, in a work which had a great vogue in its day—the "Vestiges of the Natural History of Creation"—of which the first edition was published in 1844.

It is full of apt and forcible illustrations of pseudo-scientific realism. Consider, for example, this gem serene: When a boy who has climbed a tree looses his hold of the branch, "the law of gravitation unrelentingly pulls him to the ground, and then he is hurt," whereby the Almighty is quite relieved from any responsibility for the accident. Here is the "law of gravitation" acting as a cause, in a way quite in accordance with the Duke of Argyll's conception of it. In fact, in the mind of the author of the "Vestiges," "laws" are existences intermediate between the Creator and his works, like the "ideas" of the Platonizers or the Logos of the Alexandrians.* I may cite a passage which is quite in the vein of Philo:

> We have seen powerful evidences that the construction of this globe and its associates, and, inferentially, that of all the other globes in space, was the result, not of any immediate or personal exertion on the part of the Deity, but of natural laws which are the expression of his will. What is to hinder our supposing that the organic creation is also a result of natural laws which are in like manner an expression of his will? (p. 154, first edition).

And creation "operating by law" is constantly cited as relieving the Creator from trouble about insignificant details.

I am perplexed to picture to myself the state of mind which accepts these verbal juggleries. It is intelligible that the Creator should operate according to such rules as he might think fit to lay down for himself (and, therefore, according to law); but that would leave the operation of his will just as much a direct personal act as it would be under any other circumstances. I can also understand that (as in Leibnitz's caricature of Newton's views) the Creator might have made the cosmical machine, and, after setting it going, have left it to itself till it needed repair. But then, by the supposition, his personal responsibility would have been involved in all that it did, just as much as a dynamiter is responsible for what happens when he has set his machine going and left it to explode.

The only hypothesis which gives a sort of mad consistency to the Vestigiarian's views is the supposition that laws are a kind of angels or demiurgoi, who, being supplied with the Great Architect's plan, were permitted to settle the details among themselves. Accepting this doctrine, the conception of royal laws and plebeian laws, and of these more than Homeric contests in which the big laws "wreck" the

* The author recognizes this in his "Explanations."

little ones, become quite intelligible. And, in fact, the honor of the paternity of those remarkable ideas which come into full flower in the preacher's discourse must, so far as my imperfect knowledge goes, be attributed to the author of the "Vestiges."

But the author of the "Vestiges" is not the only writer who is responsible for the current pseudo-scientific mystifications which hang about the term "law." When I wrote my paper about "Scientific and Pseudo-Scientific Realism," I had not read a work by the Duke of Argyll, "The Reign of Law," which, I believe, has enjoyed, possibly still enjoys, a wide-spread popularity. But the vivacity of the duke's attack led me to think it possible that criticisms directed elsewhere might have come home to him. And, in fact, I find that the second chapter of the work in question, which is entitled "Law; its Definitions," is, from my point of view, a sort of "summa" of pseudo-scientific philosophy. It will be worth while to examine it in some detail.

In the first place, it is to be noted that the author of the "Reign of Law" admits that "law," in many cases, means nothing more than the statement of the order in which facts occur, or, as he says, "an observed order of facts" (p. 66). But his appreciation of the value of accuracy of expression does not hinder him from adding, almost in the same breath, "In this sense the laws of Nature are simply those facts of Nature which recur according to rule" (p. 66). Thus "laws," which were rightly said to be the statement of an order of facts in one paragraph, are declared to be the facts themselves in the next.

We are next told that, though it may be customary and permissible to use "law" in the sense of a statement of the order of facts, this is a low use of the word; and indeed, two pages farther on, the writer, flatly contradicting himself, altogether denies its admissibility:

> An observed order of facts, to be entitled to the rank of a law, must be an order so constant and uniform as to indicate necessity, and necessity can only arise out of the action of some compelling force (p. 68).

This is undoubtedly one of the most singular propositions that I have ever met with in a professedly scientific work, and its rarity is embellished by another direct self-contradiction which it implies. For, on the preceding page (67), when the Duke of Argyll is speaking of the laws of Kepler, which he admits to be laws, and which are types of that which men of science understand by "laws," he says that they are "simply and purely an order of facts." Moreover, he adds, "A very large proportion of the laws of every science are laws of this kind and in this sense."

If, according to the Duke of Argyll's admission, law is understood in this sense, thus widely and constantly, by scientific authorities, where is the justification for his unqualified assertion that such statements of the observed order of facts are not "entitled to the rank" of laws?

But let us examine the consequences of the really interesting proposition I have just quoted. I presume that it is a law of Nature that "a straight line is the shortest distance between two points." This law affirms the constant association of a certain fact of form with a certain fact of dimension. Whether the notion of necessity which attaches to it has an *a priori* or an *a posteriori* origin is a question not relevant to the present discussion. But I would beg to be informed, if it is necessary, where is the "compelling force" out of which the necessity arises; and, further, if it is not necessary, whether it loses the character of a law of Nature?

I take it to be a law of Nature, based on unexceptionable evidence, that the mass of matter remains unchanged, whatever chemical or other modifications it may undergo. This law is one of the foundations of chemistry. But it is by no means necessary. It is quite possible to imagine that the mass of matter should vary according to circumstances, as we know its weight does. Moreover, the determination of the "force" which makes mass constant (if there is any intelligibility in that form of words) would not, so far as I can see, confer any more validity on the law than it has now.

There is a law of Nature, so well vouched by experience that all mankind, from pure logicians in search of examples to parish sextons in search of fees, confide in it. This is the law that "all men are mortal." It is simply a statement of the observed order of facts that all men sooner or later die. I am not acquainted with any law of Nature which is more "constant and uniform" than this. But will any one tell me that death is "necessary"? Certainly there is no *a priori* necessity in the case, for various men have been imagined to be immortal. And I should be glad to be informed of any "necessity" that can be deduced from biological considerations. It is quite conceivable, as has recently been pointed out, that some of the lowest forms of life may be immortal, after a fashion. However this may be, I would further ask, supposing "all men are mortal" to be a real law of Nature, where and what is that to which, with any propriety, the title of "compelling force" of the law can be given?

On page 69, the Duke of Argyll asserts that the law of gravitation "is a law in the sense not merely of a rule but of a cause." But this revival of the teaching of the "Vestiges" has already been examined and disposed of; and, when the Duke of Argyll states that the "observed order," which Kepler had discovered, was simply a necessary consequence of the force of "gravitation," I need not recapitulate the evidence which proves such a statement to be wholly fallacious. But it may be useful to say once more that, at this present moment, nobody knows anything about the existence of a force of gravitation apart from the fact; that Newton declared the ordinary notion of such force to be inconceivable; that various attempts have been made to account for the order of facts we call gravitation, without recourse to the notion of attractive force; that, if such a force exists, it is utterly incompetent to account for Kepler's laws, without taking into the reckoning a great number of other considerations; and, finally, that all we know about the "force" of gravitation, or any other so-called "force," is that it is a name for the hypothetical cause of an observed order of facts.

Thus, when the Duke of Argyll says, "Force, ascertained according to some measure of its operation—this is, indeed, one of the definitions, but only one, of a scientific law" (p. 71), I reply that it is a definition which must be repudiated by every one who possesses an adequate acquaintance with either the facts or the philosophy of science, and relegated to the limbo of pseudo-scientific fallacies. If the human mind had never entertained this notion of "force," nay, if it substituted bare, invariable succession for the ordinary notion of causation, the idea of law, as the expression of a constantly observed order, which generates a corresponding intensity of expectation in our minds, would have exactly the same value, and play its part in real science, exactly as it does now.

It is needless to extend further the present excursus on the origin and history of modern pseudo-science. Under such high patronage as it has enjoyed, it has grown and flourished, until, nowadays, it is becoming somewhat rampant. It has its weekly "Ephemerides," in which every new pseudo-scientific mare's-nest is hailed and belauded with the unconscious unfairness of ignorance; and an army of "reconcilers," enlisted in its service, whose business seems to be to mix the black of dogma and the white of science into the neutral tint of what they call liberal theology.

I remember that, not long after the publication of the "Vestiges," a shrewd and sarcastic countryman of the author defined it as "cauld kail made het again." A cynic might find amusement in the reflection that, at the present time, the principles and the methods of the much-vilified Vestigiarian are being "made het again"; and are not only "echoed by the dome of St. Paul's," but thundered from the castle of Inverary. But my turn of mind is not cynical, and I can but regret the waste of time and energy bestowed on the endeavor to deal with the most difficult problems of science, by those who have neither undergone the discipline, nor possess the information which are indispensable to the successful issue of such an enterprise.

I have already had occasion to remark that the Duke of Argyll's views of the conduct of controversy are different from mine; and this much-to-be-lamented discrepancy becomes yet more accentuated when the duke reaches biological topics. Anything that was good enough for Sir Charles Lyell, in his department of study, is certainly good enough for me in mine; and I by no means demur to being pedagogically instructed about a variety of matters with which it has been the business of my life to try to acquaint myself. But the Duke of Argyll is not content with favoring me with his opinions about my own business; he also answers for mine; and, at that point, really the worm must turn. I am told that "no one knows better than Professor Huxley" a variety of things which I really do not know; and I am said to be a disciple of that "Positive Philosophy" which I have, over and over again, publicly repudiated in language which is certainly not lacking in intelligibility, whatever may be its other defects.

I am told that I have been amusing myself with a "metaphysical exercitation or logomachy" (may I remark incidentally that these are not quite convertible terms?), when, to the best of my belief, I have been trying to expose a process of mystification, based upon the use of scientific language by writers who exhibit no sign of scientific training, of accurate scientific knowledge, or of clear ideas respecting the philosophy of science, which is doing very serious harm to the public. Naturally enough, they take the lion's skin of scientific phraseology for evidence that the voice which issues from beneath it is the voice of Science, and I desire to relieve them from the consequences of their error.

The Duke of Argyll asks, apparently with sorrow that it should be his duty to subject me to reproof:

> What shall we say of a philosophy which confounds the organic with the inorganic, and, refusing to take note of a difference so profound, assumes to explain, under one common abstraction, the movements due to gravitation and the movements due to the mind of man?

To which I may fitly reply by another question: What shall we say to a controversialist who attributes to the subject of his attack opinions which are notoriously not his; and expresses himself in such a manner that it is obvious he is unacquainted with even the rudiments of that knowledge which is necessary to the discussion into which he has rushed?

What line of my writing can the Duke of Argyll produce which confounds the organic with the inorganic?

As to the latter half of the paragraph, I have to confess a doubt whether it has any definite meaning. But I imagine that the duke is alluding to my assertion that the law of gravitation is nowise "suspended" or "defied" when a man lifts his arm; but that, under such circumstances, part of the store of energy in the universe operates on the arm at a mechanical advantage as against the operation of another part. I was simple enough to think that no one who had as much knowledge of physiology as is to be found in an elementary primer, or who had ever heard of the greatest physical generalization of modern times—the doctrine of the conservation of energy—would dream of doubting my statement; and I was further simple enough to think that no one who lacked these qualifications would feel tempted to charge me with error. It appears that my simplicity is greater than my powers of imagination.

The Duke of Argyll may not be aware of the fact, but it is nevertheless true, that when a man's arm is raised, in sequence to that state of consciousness we call a volition, the volition is not the immediate cause of the elevation of the arm. On the contrary, that operation is effected by a certain change of form, technically known as "contraction" in sundry masses of flesh, technically known as muscles, which are fixed to the bones of the shoulder in such a manner that, if these muscles contract, they must raise the arm. Now, each of these muscles is a machine, in a certain sense, comparable to one of the donkey-engines of a steamship, but more complete, inasmuch as the source of its ability to change its form, or contract, lies within itself. Every time that, by contracting, the muscle does work, such as that involved in raising the arm, more or less of the material which it contains is used up, just as more or less of the fuel of a steam-engine is used up, when it does work. And I do not think there is a doubt in the mind of any competent physicist or physiologist that the work done in lifting the weight of the arm is the mechanical equivalent of a certain proportion of the energy set free by the molecular changes which take place in the muscle. It is further a tolerably well-based belief that this, and all other forms of energy, are mutually convertible, and therefore that they all come under that general law or statement of the order of facts called the conservation of energy. And, as that certainly is an abstraction, so the view which the Duke of Argyll thinks so extremely absurd is really one of the commonplaces of physiology. But this Review is hardly an appropriate place for giving instruction in the elements of that science, and I content myself with recommending the Duke of Argyll to devote some study to Book II, Chapter V, section 4, of my friend Dr. Foster's excellent "Text-Book of Physiology" (first edition, 1877, p. 321), which begins thus:

> Broadly speaking, the animal body is a machine for converting potential into actual energy. The potential energy is supplied by the food; this the metabolism of the body converts into the actual energy of heat and mechanical labor.

There is no more difficult problem in the world than that of the relation of the state of consciousness, termed volition, to the mechanical work which frequently follows upon it. But no one can even comprehend the nature of the problem who has not carefully studied the long series of modes of motion which, without a break, connect the energy which does that work with the general store of energy. The ultimate form of the problem is this: Have we any reason to believe that a feeling, or state of consciousness, is capable of directly affecting the motion of even the smallest conceivable molecule of matter? Is such a thing even conceivable? If we answer these questions in the negative, it follows that volition may be a sign, but can not be a cause of bodily motion. If we answer them in the affirmative, then states of consciousness become undistinguishable from material things;

for it is the essential nature of matter to be the vehicle or substratum of mechanical energy.

There is nothing new in all this. I have merely put into modern language the issue raised by Descartes more than two centuries ago. The philosophies of the Occasionalists, of Spinoza, of Malebranche, of modern idealism and modern materialism, have all grown out of the controversies which Cartesianism evoked. Of all this the pseudo-science of the present time appears to be unconscious; otherwise it would hardly content itself with "making het again" the pseudo-science of the past.

In the course of these observations I have already had occasion to express my appreciation of the copious and perfervid eloquence which enriches the Duke of Argyll's pages. I am almost ashamed that a constitutional insensibility to the Sirenian charms of rhetoric has permitted me, in wandering through these flowery meads, to be attracted almost exclusively to the bare places of fallacy and the stony grounds of deficient information which are disguised, though not concealed, by these floral decorations. But, in his concluding sentences, the duke soars into a Tyrtæan strain which roused even my dull soul:

> It was high time, indeed, that some revolt should be raised against that Reign of Terror which had come to be established in the scientific world under the abuse of a great name. Professor Huxley has not joined this revolt openly, for as yet, indeed, it is only beginning to raise its head. But more than once—and very lately—he has uttered a warning voice against the shallow dogmatism that has provoked it. The time is coming when that revolt will be carried further. Higher interpretations will be established. Unless I am much mistaken, they are already coming in sight (p. 339).

I have been living very much out of the world for the last two or three years, and when I read this denunciatory outburst, as of one filled with the spirit of prophecy, I said to myself: "Mercy upon us! what has happened? Can it be that X and Y (it would be wrong to mention the names of the vigorous young friends which occurred to me) are playing Danton and Robespierre; and that a guillotine is erected in the court-yard of Burlington House for the benefit of all anti-Darwinian Fellows of the Royal Society? Where are the secret conspirators against this tyranny, whom I am supposed to favor, and yet not have the courage to join openly? And to think of my poor oppressed friend, Mr. Herbert Spencer, 'compelled to speak with bated breath' (p. 338) certainly for the first time in my thirty-odd years' acquaintance with him!" My alarm and horror at the supposition that, while I had been fiddling (or at any rate physicking), my beloved Rome had been burning, in this fashion, may be imagined.

I am sure the Duke of Argyll will be glad to hear that the anxiety he created was of extremely short duration. It is my privilege to have access to the best sources of information, and nobody in the scientific world can tell me anything about either the Reign of Terror or the Revolt. In fact, the scientific world laughs most indecorously at the notion of the existence of either; and some are so lost to the sense of the scientific dignity, that they descend to the use of transatlantic slang, and call it a "bogus scare." As to my friend Mr. Herbert Spencer, I have every reason to know that, in the "Factors of Organic Evolution," he has said exactly what was in his mind, without any particular deference to the opinions of the person whom he is pleased to regard as his most dangerous critic and devil's advocate-general, and still less of any one else.

I do not know whether the Duke of Argyll pictures himself as the Tallien of this imaginary revolt against a no less imaginary Reign of Terror. But if so, I most respectfully but firmly decline to join his forces. It is only a few weeks since I happened to read over again the first article which I ever wrote (now twenty-seven years ago) on the "Origin of Species," and I found nothing that I wished to modify in the opinions that are there expressed, though the subsequent vast accumulation of evidence in favor of Mr. Darwin's views would give me much to add. As is the case with all new doctrines, so with that of evolution, the enthusiasm of advocates has sometimes tended to degenerate into fanaticism, and mere speculation has, at times, threatened to shoot beyond its legitimate bounds. I have occasionally thought it wise to warn the more adventurous spirits among us against these dangers, in sufficiently plain language; and I have sometimes jestingly said that I expected, if I lived long enough, to be looked on as a reactionary by some of my more ardent friends. But nothing short of midsummer madness can account for the fiction that I am waiting till it is safe to join openly a revolt, hatched by some person or persons unknown, against an intellectual movement with which I am in the most entire and hearty sympathy. It is a great many years since, at the outset of my career, I had to think seriously what life had to offer that was worth having. I came to the conclusion that the chief good, for me, was freedom to learn, think, and say what I pleased, when I pleased. I have acted on that conviction, and have availed myself of the "rara temporum felicitas ubi sentire quæ velis, et quæ sentias dicere licet," which is now enjoyable, to the best of my ability; and though strongly, and perhaps wisely, warned that I should probably come to grief, I am entirely satisfied with the results of the line of action I have adopted.

My career is at an end—

> I have warmed both hands at the fire of life;

and nothing is left me, before I depart, but to help, or at any rate to abstain from hindering, the younger generation of men of science in doing better service to the cause we have at heart, than I have been able to render.

And yet, forsooth, I am supposed to be waiting for the signal of "revolt," which some fiery spirits among these young men are to raise before I dare express my real opinions concerning questions about which we older men had to fight, in the teeth of fierce public opposition and obloquy—of something which might almost justify even the grandiloquent epithet of a Reign of Terror—before our excellent successors had left school.

It would appear that the spirit of pseudo-science has impregnated even the imagination of the Duke of Argyll. The scientific imagination always restrains itself within the limits of probability.—*Nineteenth Century*.

## GOFIO: FOOD AND PHYSIQUE.

By C. FAYETTE TAYLOR, M. D.

ON a recent visit to the Canary Islands, one of the first things to attract my notice was the good development and fine personal appearance of the common people. I afterward found that travelers are generally impressed in the same manner on their first visit to the Canaries. If they have previously visited the Spanish Peninsula, they are apt to contrast the native Spaniards with their Canarian relatives, always in favor of the latter, whose greater height and better bodily forms are very evident. This superiority may be due, in a certain degree, to the admixture of the Spanish blood with that of the Guanche race, which was found in possession, when, in 1440, the Spanish undertook the conquest of the Canarian Archipelago. It required more than fifty years for the purpose, and not until, to the utmost efforts of Spain, then in the height of her power, the treachery of four native kings had been added, did all the seven islands come under Spanish rule. The old chroniclers are fond of describing the mild and sweet dispositions of the Guanches, their tall, manly figures, and noble bearing in time of peace, as well as their great strength and valor when fighting to preserve their ancient liberty.

Even the women took part against the invaders, and proved themselves, in daring and prowess, no mean antagonists. One woman is especially mentioned who rushed upon an advancing column, seized the foremost soldier and fled up the mountain, bearing her victim as if he had been a child, outstripping her pursuers, till, coming to a precipice, she leaped down and both were dashed to pieces.

The conquerors not only mingled their blood with the conquered, as happens with the Latin races, but they adopted many of their customs, some of which are preserved to the present time. Perhaps the most important of these is in relation to their food, the principal article of which is of Guanche origin.

I have alluded to the excellent bodily development and proportions of the modern Canarians, and to the testimony left by the old chroniclers to the still fine characteristics of the ancient Guanches, who are indeed described as marvels of bodily strength, beauty, and agility, because these facts have an important bearing on the question of their food. As there can be no such bodily growth, strength, and activity, as is described as belonging to these people, without superior nourishment, it follows that the food used by the Guanches, and adopted and still almost exclusively used by the present inhabitants, must be highly nutritious.

This article, so evidently important, is the *gofio*, named at the head of this paper. There is nothing mysterious about it, for gofio is simply flour made from any of the cereals by parching or roasting before grinding. The Guanches may have roasted their wheat, barley, etc., by the ready method of first heating stones, on which or among which the grain was afterward placed. As to that there are no precise accounts, but well-shaped grinding-stones are plentifully preserved. At present gofio is prepared by roasting the grain in a broad, shallow earthen dish, over a charcoal-fire. It is kept constantly stirred, to prevent burning. One can hardly pass through a village or hamlet without witnessing some stage of the preparation of gofio. The grain is first carefully picked over and all impurities removed. The processes frequently take place in front of or just within the always-open door, giving the traveler ample opportunity to see all steps of the preparation. The grinding is done at the wind-mills, which abound everywhere. The roasted grain is ground to a very fine flour, when it becomes gofio. After grinding it is ready for immediate use. When it is to be eaten, milk, soup, or any suitable fluid, may be mixed with it—anything, in fact, to give it sufficient consistency to be conveyed into the mouth. Being already cooked, it requires no further preparation before eating.

Ultimately maize was introduced into the islands, and soon became an article of general cultivation, particularly on the Island of Grand Canary, where gofio from it is the staple article of food for the laboring population, as that from wheat or wheat mixed with maize is in Teneriffe, wheat being more largely grown in the latter island. Gofio is also made from barley, and especially in Fuerteventura. It is also made from Spanish beans; but this kind is not used alone, but to mix in the proportion of about one fourth to three fourths of wheat, barley, or maize gofio, as some prefer. Wheat and corn gofio, mixed in equal proportions, is very much used, and is preferred by many to either article alone. Nothing can exceed the extreme handiness of this ready-cooked article of food. The Canarian laborer, if alone, takes some gofio in a bag made of the stomach of a kid; if there are several persons, the skin of a kid is used. When the hour for the simple meal has arrived, the bag is extracted from some pocket, or, likely enough, from the girdle, and putting a little water into it, after being well shaken, the meal is ready. Only enough water is added to make it sufficiently consistent to be readily taken in the hand, from which it is invariably eaten. The preparation occupies no appreciable time. The winter before last I saw one or two hundred Italian workmen repairing the retaining wall to a river, and had reason to admire both their industry and their simple, frugal habits. As the mid-day hour approached, one of a gang of ten or twelve men would step aside and prepare the dinner. It nearly always consisted of *polenta*, or Indian-corn meal boiled in water. It took the best part of an hour to prepare it, and there was also the trouble of kettles, fires, providing wood, besides many antecedent preparations, even when cooking was thus reduced to its simplest proportions. The Canarian laborer has no such trouble. The roasting of the grain is more quickly done than cooking polenta, and can be prepared in larger quantity by the wife at home.

The grinding is the same in both cases, but gofio has the great advantage of being easily carried about the person in a bag, and is always ready to be eaten. It is also much more palatable. The Canarian Archipelago consists of seven inhabited islands with a population of two hundred and forty thousand persons. From the best information I could get, I should think that fully two hundred thousand of them live almost exclusively on gofio, as their fathers have done before them, including their Guanche predecessors, from time immemorial. I have been thus particular in giving, in some detail, the origin, preparation, and importance of gofio in sustaining a large population, because I believe this article to be worthy of attention on the part of purveyers of farinaceous foods. If introduced into the United States, it would add a delicious, wholesome, and highly nutritious article of food, very convenient to use, to our already large variety. But gofio has other claims to our attention and favor than its economy, convenience, and evident highly nutritive qualities.

Finding it used, not only by the common people, for whom it constitutes the chief article of sustenance as already stated, but also in the homes of the wealthier citizens, children being especially fond of and thriving well on it, I tried specimens of both wheat and maize gofio and found them very palatable—the maize especially so, having a delicious, aromatic flavor which soon made me prefer it to bread, especially in the morning. Very soon gofio, with a soft-boiled egg, goat's milk, and coffee, constituted a satisfactory breakfast. In fact, I liked it so well, and found it so digestible and nutritious, that I kept to it and throve on it till, at the end of two months, it occurred to me that during that time there had been no instance of "acid stomach" to which, in the best of times, I had always been subject. I left Teneriffe soon after, and during the voyage, and for some time after landing in the West Indies, the gofio-breakfast was suspended. After some weeks without it, the acidity returned very severely, owing to exposure and fatigue. And, as usual, acidity once established, persistently continued. After suffering several days I thought of the gofio, a small quantity of which we had brought from Teneriffe. On eating it for breakfast, as I had done before, the acidity immediately disappeared and has not returned.

In this connection I would say that I had previously observed the same phenomenon of complete exemption from acid stomach while using Carlsbad Zwieback, as the sole farinaceous food at breakfast. Zwieback, as most persons already know, is bread cut in thick slices and baked a second time. In Carlsbad the second baking is carried so far that the slice is browned through its entire thickness. If there remains a white central portion it is not good, and will undergo acid decomposition in the dyspeptic stomach when the properly made Zwieback will remain for a long time unchanged except by gastric fluids. But, while useful as a temporary expedient, Zwieback has not much nutrition after undergoing the three processes of raising, baking, and rebaking to incipient carbonizing. It is incapable of being used alone as a sufficient aliment. To gofio there is no such objection. The roasting is the first and only cooking of the food. Gofio is a food dry cooked, no fluid coming to it till the very moment of eating it; and we know that dry heat produces changes in the structure and composition of cereals different from those produced by moist heat. The roasting process is essentially different from the steaming, baking, or boiling process, and, for one thing, converts starchy particles into more soluble and more friable forms. Moderately browned bread-crust illustrates the change produced.

Perhaps the roasting process has a protecting efficacy against the action of the ferments which are always present in the alimentary tract, ready to effect some form of decomposition should digestion be long enough delayed to allow them to act. In fact, there is no doubt that, in many cases, the stomach actually becomes a receptacle for the cultivation of microbes. As one meal after the other is taken into the stomach, each succeeding mass of fermentable material is affected by the ferment-germs developed and energized by those which have preceded it, till a high degree of potency is reached as in the usual method of bacteria cultivation. In such a case normal digestion is anticipated by fermentation, the wholesomeness of the food is impaired by antecedent decomposition, the gastric power is lessened by contact with noxious acids and gases, and we have the confirmed dyspeptic. The worst of it is, that such a condition is self-propagating, all ordinary means failing to energize digestion or to de-energize the ferment that the former may precede the latter in the usual way. Even the useful and often indispensable stomach-pump sometimes fails to prevent prompt fermentation of the first food taken after its careful use for cleansing purposes. In all my previous personal and professional experience, I found, when once the rapid acidulation of the food demonstrated the potentialization of the microbic ferment, there was no so sure way to overcome it as, in turn, to energize the digestive action by prolonged abstinence from food. In that case the ferment becomes itself digested and de-energized and acts more slowly than the digestive process.

After this the ever-present but now non-energized ferment-germs act tardily, till some accident of overdoing, or bad eating, or other cause, again delays digestion till fermentation is set up in the gastric cavity, and the cultivation process above described is renewed, when there is another attack of acidity of the stomach, difficult to bear and difficult to get rid of, as every unfortunate dyspeptic and every unfortunate physician to such a patient full well know to their sorrow. But the starving-out process is not easy, and is not applicable in many cases; besides, not every one has the resolution for it, when it might be proper and effective. If, in gofio, already demonstrated to have the essentials of high nutrition and palatableness, we have an article of food capable of resisting the acid decomposition for a much longer time than the ordinary preparations of farinacea, it will be an inestimable boon to all civilized communities to make the fact known to them.

I have set on foot trials of the value of gofio, in such cases as are appropriate, to carefully determine its influence in preventing gastric acidity. Whether the impressions, formed, as above described, after several months' personal experience, are to be sustained or to be found groundless, will be known in due time by ample clinical demonstrations. But, considering the importance of the subject to so many persons, and to the end that experiments in the use of gofio in appropriate cases may be multiplied, I do not hesitate to place my (as yet) unsupported personal experience before the profession and public for their careful consideration.

## SOCIAL SUSTENANCE.

### II.—COMBINATION OF EFFORT.

By HENRY J. PHILPOTT.

PERHAPS we may now enter on a more detailed examination of the nature and methods of the help that human beings in the social state render one another in making a living. The best way to do this will be to begin with the simple and proceed to the complex. It is all done by the combination of our efforts—not their aggregation simply, but their combination. We must carefully note the difference. Aggregation is a mere pooling of products or results. At any rate, let us so use the word. It may be illustrated by two fishermen fishing on the river-bank with hook and line, and dividing the catch at night. No more fish will be caught than if each fished separately and carried home his own catch.

But suppose they take a seine, they may catch ten times as many as they could working separately. They have now *combined* their efforts, which before were merely added together. The combination has brought forth a new and enlarged result. It has increased the result geometrically. By uniting and helping each other, they have gained a better living than they could possibly have got by working separately.

This way of uniting human effort let us call combination. But we need not enter into any quibble as to the precise place to draw the line between aggregation and combination. If anybody chooses to confuse the two, no economic argument will be affected one way or the other. If the distinction does not beget clearness of thought, it will have served no purpose whatever, and may be ignored; for, henceforth, we shall mostly be thinking about *combination*, and very seldom of mere pooling or aggregation of effort.

1. The simplest form of combination is where two or more men carry a burden too heavy for either alone, but which can not be divided. Pall-bearers, or the bearers of a sedan-chair, or track-layers on a railroad, or the builders of a log-house, illustrate this extremely simple and direct form of the combination of human effort to bring about a result unattainable by separate effort. Even in this simple form of mutual helpfulness it is plainly seen that two and two do not make four—they make five, or ten, or a hundred.

2. The next most simple form of combination is where two or more persons are working at the same undertaking in the same place, or under the same management, but attending to different parts of it. Every factory, mill, shop, store, or jobbing-house, illustrates this form. There are division and diversity of work, but the product is one. So it is with the players in a play. Their parts are diverse, but the play is a unit, and they all work together. Here it is plainer than ever that ten or fifteen human beings, by combining their efforts, can do for us in three hours what one person could not do in a lifetime.

3. One step more in the direction of complexity, and we reach a form of combination wherein all still contribute to the production of a single article or result, but work in different places, different factories, different countries, perhaps, and especially under different management or conditions. A striking example of this is the cotton-grower, whose immediate product is of extremely little use until it has been transported many miles and been worked upon by another set of human beings, generally of a different race and color. But this is only one example, though perhaps the most striking, of the third form of combination of human effort, in which persons widely separated by space as well as by diversity of gifts and employments, jointly contribute to a single and strictly unified product or result.

It is often a business question with the leader of an enterprise whether he shall adopt the second or third form of combination; and still oftener how far he shall follow one and how far the other. In some industries the tendency is one way, and in some the other. In still others it is merely a question of how much of the work each contributor shall do. Shall the iron-master buy his iron in the bar, in the pig, or in the ore? Shall the woolen manufacturer buy his wool in the crude web, in the yarn, or in the fleece? Fifty years ago it was quite common for the same family to rear and shear the sheep, wash the fleece, card it, spin it, weave it, color it, and make it into clothing—though different members of the family attended to different parts of the work. That was a combination of the second form. At present wool-growing and woolen-manufacturing are separated. Sometimes the spinning and weaving are separated. As a rule, the weaving and making are separated.

It is into this third form of combination that what is called *exchange* enters. Exchange is so important a phenomenon that political economy is often called the science of exchanges. This definition, as we now see, narrows its field. The real subject-matter of political economy is the mutual helpfulness of human beings in making a living. Exchange is only one of the ways of making this helpfulness effective. None the less, persons between whom exchange is hindered or prohibited are to that extent kept from helping one another to make a living. The wool-grower and the sheep-shearer are just as truly engaged in the production of cloth as the weaver. If the wool-grower is prohibited from furnishing wool to the weaver, it is plain that both are hindered in their joint work.

4. In the fourth form of combination, also, exchange prevails as a prominent feature. But here we take leave of one feature which has thus far characterized all forms of combination. It is *unity of product*. Each party now completes his product, ready to enter into the living of a fellow-being. One hunts and the other fishes, and the hunter trades game for fish. Each then has for his supper a variety consisting of game and fish. Rarely, indeed, is the exchange so simple as this. In civilized societies it is highly complex, and its problems baffle the best of brains. If we sit down to a meal, we find that one set of men have furnished us the table, another set the table-cloth, another the dishes, another the silver, another the bread, another the butter, another the pepper, another the salt, another the sugar, another the coffee, another this, and another that, until a score of groups and thousands of persons might be counted, all of whom have helped us to get our dinner—to make our living.

5. There is a fifth form of combination, more simple than the third or fourth, and yet in one sense more complex. In this the service rendered on one side is direct, and on the other indirect. There is no exchange of products, and, in fact, generally no product. The physician, the minister, the lawyer, the teacher, and the housemaid, all help us in making a living. They do not help us by making some material thing and sending it to us. They help us personally and directly. We in

return help them by giving them the money we have got for helping somebody else, and with it they buy the products or services of still other people.

The doctor helps the lawyer to get well. The lawyer helps the doctor to get something to eat and wear, by giving him some of the money he has got for helping other people to get their rights in the courts.

The mutual help of man and wife is usually in this form. Only in this case there is no stipulated return service for what the wife does, and she gets part of her reward in money and part in goods. She is to have her living—this the law provides. If the case comes into court, the *amplitude* of her living may be fixed, or rather the amplitude of her means of living. Otherwise, she may render a large service for a poor living, or get a good living for no service at all. But whatever service she does render is rendered directly, and it also, like the finished product in the fourth combination, enters immediately into the living of the other party to the mutual helpfulness.

6. There is a sixth combination of human effort, and a very important one. It is the combination of past with successive present efforts. In one form of it the material product of the past effort is called capital. In other forms it is non-material, and is called skill, education, training, reputation, prestige, or good-will. If a fisherman spends a week making a boat, we say he has spent a week accumulating capital. But if he spends five days learning how, and makes the boat in a day, we say he has spent a day in the production of capital. If he spends another week in learning to row it, he has still spent but one day in the accumulation of capital. But, none the less, he has done two weeks' work which will never bear fruit until it is combined with future work, and then it will (presumably) fertilize that future work and increase its fruitage.

So the past work of the dead father is combined with the present work of the living son. This, not only as embodied in the estate which he left him, but as manifested in his education, moral, mental, and manual. This combination links us to the whole past and the whole future. It needs to be very carefully studied.

For instance, the hasty critic may say that it is identical with the third combination, since in that the past labor of the cotton-planter is combined with the present labor of the weaver. But this criticism misses the point. In the third combination we combine the past efforts of others with our own present efforts in a single combination, resulting in a single product or service. In the sixth combination we combine identical past efforts, which may be our own, with a *succession* of our own present efforts, to produce a succession of similar or different products or services. Any individual fiber of cotton, once woven into cloth, and worn, is extinct; but the boat of the fisherman may be used over and over again for fishing, for hunting, for necessary journeys, or for pleasure.

So skill, once acquired, is combined with all future efforts in the same line, or even in slightly different lines.

Care must be taken not to confound our sixth combination with the ideas conveyed by the word "capital." Cotton produced, and not yet woven or worn, is called capital. It is not necessary for us to quarrel with that use of the term. We may use it in the same way without detriment to the clearness of our ideas, or the force of logic. For that matter, we may call anything capital which has been produced and not yet consumed. We shall have only incidental use for the term, and in most cases the ordinary business sense of it will do.

These six forms of the combination of human efforts for the purpose of securing an increase of results more than commensurate with the increase of effort are, like the simple elements in chemistry or the three forms of the lever in mechanics, generally found united or co-working, and in an infinite variety of ways. Thus, as between themselves, the actors in a play exemplify the second combination; as between them and the audience, the combination is of the fifth form. So, in the production of cotton cloth, there is combination in the second form as between the different classes of operatives in the factory, and combination in the third form as between all the factory operatives and all the employés in the cotton-field.

But we plainly see that the sustenance of civilized human beings is the work of a mutual-aid society of stupendous proportions and well-nigh inscrutable complexity. To a rapidly growing extent it takes in the whole world. But the greater the civilization the greater the complexity, and the greater the proportion of mutual helpfulness to immediate self-helpfulness. Hence the greater difficulty, but at the same time the greater necessity, of a thorough study of the methods of this mutual helpfulness, and of the terms on which it is rendered.

To this study I hope to contribute something, and I shall not be disappointed if it is something very far short of a revolution. It may be nothing but the discovery, or selection, or utilization of a new point of view. But even this may enable some fellow-student of taller stature to catch a glimpse of some landmark, or alignment of landmarks, which will prove a key to the whole situation. Political economy has been termed the science of *wealth*; in order to widen the field, "wealth" has been called "weal"; again, it has been called the science of *exchanges*, and again the word "exchanges" has been widened to admit of an evidently needed expansion of treatment. I propose to let these words shrink back to their every-day meaning, and adopt a treatment and a definition of the science which will take in every effect of social relations on individual sustenance of every degree of amplitude. For want of a better term to express this broad view, I have translated "political economy" into "social sustenance." The new term is intended to interpret, and not to supersede, the old one.

I have with extreme brevity outlined the hindrances as well as the helps that socially organized human beings offer us in our sustenance. The latter I have classified into six forms of combination (not always exchange) of effort, as follows :

1. Unity of completed service, immediate union of contributors, homeogeneity of functions.

2. Unity of completed service, immediate union of contributors, specialization of functions.

3. Unity of completed service, specialization of functions, separation of contributors.

4. Diversity of completed service, specialization of functions, separation of contributors, service embodied in material commodities.

5. Diversity of completed services, embodied in commodities on one side only, or neither, specialization of functions, contributors sometimes united (as man and wife) in the final purpose of making a living.

6. Combination of past with successive present efforts, all by the same or by different contributors, completed services personal or embodied in commodities.

Whether the list might be extended, or ought to be condensed, is for others to say. In its present form it can hardly be more than suggestive, for its whole line of study is entirely novel, so far as I know. A rigid adherence to it, however, is not essential to my general view of the science, nor to any part of a minute discussion in accordance with that view. At the same time I am inclined to think that some such classification might be made not only highly instructive, but quite convenient for reference.

## INDUSTRIAL EDUCATION AND RAILWAY SERVICE.*

MUCH has been heard, during the discussions of the labor question, about the rights and interests of manufacturers and of workmen, but comparatively very little about the claims of the work. While the contention between manufacturers and their men has always been hot, and sometimes vital, the product of their joint energy, upon the best availability of which for its intended purpose the life of both parties depends, has been left to shift for itself. Producers have relaxed their pains to secure the best possible product, in order that they might put more money into their pockets, or recoup themselves for the losses they have had to suffer by the antagonism of their men ; and workmen have, in obedience to some "union" or "chapter," systematically slighted their work, as one of the means by which they imagined they might get even with the capitalists. The result has been, in

* Abridged from a report by Dr. W. T. Barnard to the President of the Baltimore and Ohio Railroad Company.

England and to some extent in the United States, a falling back in the standard of manufactured products, and decline of trade in them, in favor of those countries in which, as in Germany, excellence and attractiveness in the executed work are recognized as entitled to equal consideration with the capitalist's desire for immediate profits and the workman's championship of "organized labor."

This tendency—for it is still, happily, in the United States a tendency rather than an accomplished fact—has been recognized most quickly by others than the parties who should seem to be most directly interested; and the efforts to counteract it have led to the establishment of several technical and art schools, either as university departments or on independent footings, some of which have proved themselves very efficient.

It has also engaged the attention of a number of manufacturing establishments and other corporations employing large bodies of workmen, who have had the sagacity to perceive that their permanent interests were identified with their turning out the best products. Among these was the Baltimore and Ohio Railroad Company, which in 1881 commended to Dr. W. T. Barnard, assistant to the president, a proposition for the establishment of a technical school for scientific and mechanical instruction, to examine into and report upon. Without waiting for his full report, the company, under Dr. Barnard's management, made a start of such a school in 1885, in connection with its shops at Mount Clare. Dr. Barnard's report has just appeared, and covers a wide ground, including a sketch of the effects of technical education in Europe; a review of its progress and present status in the United States; discussions of the need of more thorough and extended technical instruction in Baltimore, and of the advantages which the Baltimore and Ohio Company, together with other railway interests, would derive from a thorough system of this character; and a programme for inaugurating systematic technical instruction in the service of that company.

To prepare himself more thoroughly for his work, Dr. Barnard, besides studying the subject in books, made personal examinations of the principal existing technical schools in the United States and Europe. The result of this investigation was so to impress him with the vital importance of technical education to the industrial and commercial interests of the United States in general as well as with the particular concerns he at first had in view; and also with the almost universal ignorance of its potency displayed by those whom it would most beneficially affect, that he has deemed it a duty to make his report one that would be generally useful.

"In Europe," says the author, "the necessity of technical education for industrial laborers, felt and freely acknowledged many years ago, was forced into prominence through the increasing rivalry between manufacturers and other producers competing with like articles in the same markets. In order to counterbalance the advantages which some manufacturers engaged in a given industry enjoyed through the possession of cheaper raw material, labor, prestige, or favorable situation, their competitors of foreign—and even of the same—nationality were compelled to look to improved methods of manufacture or production in order to hold their ground, and were thus brought to realize that educated labor and technical skill were the soundest elements with which to defend themselves in trade competition, in that they promote excellence of execution, inventiveness, enterprise, and all the qualities required to successfully conduct progressive industries. Under this pressure producers and manufacturers, through their guilds and other associations, were soon able to exert an influence upon their governments which has resulted in every European nation's making greater or less provision for public industrial education ; until at this time not only England, France, Germany, Austria, Switzerland, Holland, and Italy, but all the minor Continental states, have their governmental schools for both elementary and higher technical instruction." Russia also has established Imperial Technical Institutes at St. Petersburg and Moscow, which are classed as among the finest in Europe, and the action of the Government has been supplemented by schools established by the leading railroads at their principal works. While the technical schools and departments in France are excellent of their kind, it is in Germany and Switzerland that the movement for industrial education has attained its highest development. In the latter country, the British Royal Commissioners found the value of its technical schools distinctly illustrated in the marked improvement of manufactures ; in the elevation of the producing classes ; in the diminution of crime ; in the popularization of education ; and, generally, exercising a most important influence upon the nation's industries and welfare. In summarizing the results of their investigations in Germany, they remark that the conviction is universal among the German people that they can only meet the competition of their rivals in other countries by training their workmen in taste and skill, and that the prosperity of their industries will increase only in proportion as they keep up the efficiency of their schools and spread their influence among the workers themselves.

The direct and indirect effects of technological schools upon the industries of their respective countries were, immediately upon their establishment, felt to be beneficial in the highest degree. Their graduates were eagerly sought out to fill important and responsible positions in manufacturing and commercial establishments, many of which had sustained serious losses through the ignorance and consequent bad management of administrative officers ; and this inquiry soon far exceeded the supply. As the result of this appreciation of, and demand for, skilled laborers and supervisors, many enterprising corporations, and even private firms, engaged in manufacturing and other industries dependent for their successful operation and development upon intelligent direction and skilled labor, individually organized scientific schools and training-classes in connection with their works. Some of these private schools are equal to or excel in particular features the government and municipal institutions. The conductors of many of them claim that the best results are obtained where intimate relationship between the school and the actual workshop is maintained; thereby facilitating the adaptation of theoretical training to the needs of the pupils and the character of the work on which they are engaged.

The leading merchants and manufacturers of Crefeld, Prussia, affirm that its silk industries largely depend for success on the influence of their technical school, which, among other things, raises the tone and increases the knowledge of rising manufacturers and foremen, and, by spreading technical education broadcast among industrious and ambitious artisans, very materially widens the field from which successful manufacturers and specialists may be chosen. At Mülhausen, Germany, manufacturers go so far as to say that their trade could not prosper without the influence of the textile museum; and citizens look upon the prosperity of the town as a result of what is learned at the technological institutions, whose action has exerted a marked influence in suppressing trade jealousies, which had almost entirely disappeared from the community. The chief hope of Verviers, Belgium, in maintaining pre-eminence in its textile industries, has been publicly acknowledged to rest upon the superiority and not on the cheapness of its productions. "This community has felt none of the evils of the late labor troubles in Belgium." The variety and excellence of the textile manufactures of Chemnitz, Saxony, are accredited by the British Royal Commissioners to the weaving-school; and the appreciation had by the citizens of the place for technical education is attested by the fact that, up to 1883, they had contributed over $440,000 for the support of their industrial schools. So, among the results that have accrued from the operation of the weaving and dyeing schools of Roubaix, France, are less need of supervision, economy in production, fewer mistakes, and more reliable and efficient work.

Of the same order with these facts is the acknowledgment said to be commonly made by the proprietors and managers of mines that young men who have been educated in technological schools heat their boilers better and with less coal than do the other workmen, and that their scientific knowledge enables them to escape many accidents and to avoid stoppage of machinery and repairs. In short, Dr. Barnard observes, "it is the testimony of all who have studied the subject that technical schools, when rightly directed, give wonderful impulses to industrial pursuits, by promoting scientific investigation and methods. Although at first this influence affects only those who attend the classes, it soon makes itself felt throughout the entire body of workmen of the community to which the school belongs, and the increased interest in scientific subjects on the part of employés, thus developed, in turn reacts to the pecuniary advantage of their employers, because mechanics who have been trained in the scientific principles that underlie their handicrafts are thereby enabled to understand the technical publications affecting their trades, and to utilize new inventions and improved methods of work ; while men uneducated in the rudiments of science ignore such sources of knowledge, and, quite naturally, oppose all improvements as innovations calculated to work injury to the laboring-classes. Cultivate a laboring-man's intelligence to a point where it recognizes improvements and comprehends their nature ; his opposition ceases, and he will himself likely invent improved processes, which will inure to his employer's benefit. Technical education has been the means of attracting capital not only to specific localities, but to countries. Indisputable evidence of this is found in Switzerland, and notably in Zürich, where for years a technical school has been conducted at government expense. When, recently, the Federal Council was disposed to lessen the usual grant for its support, the manufacturers showed, by undeniable evidence, that this single institution had in a few years been the means of bringing capital to the country to the extent of millions of pounds sterling."

The British Royal Commissioners testify that a few years ago the question of technical education in England would have been a debatable one, but that now no argument is needed to convince English employers of its importance ; that it has been tried, and has given the highest satisfaction ; that in nearly all the great industrial centers schools of science and art, of various grades, together with numerous art and science classes, are to be found in successful operation, and that their influence may be traced in the improved productions of the localities in which they are placed ; in the decreased consumption of crude material, and in saving of time required for the performance of labor. Through the agency of technical schools, wherever they have been established, originality has taken the place of servile imitation ; decaying industries have been revived, and new ones promoted ; while they have exerted a most marked influence in developing the intelligence and skill, and consequently in securing the permanent prosperity of the industrial classes generally, by enabling them to develop the sources of wealth peculiar to each country.

A noteworthy example of the collective advantages which technical education can confer is afforded by Switzerland, a country which is without navigable rivers, canals, mines, fertility, and the other natural gifts which are the usual foundation of the prosperity of civilized states, but where industrial education is highly developed. From it are yearly exported industrial products exceeding in value all the importations of the cantons, and also more than sufficient to cover the cost of internal administration.

If the results of an educational system can be ascertained from a close inspection of those industries in which the mass of a country's population is engaged, and in which their knowledge is displayed by the fruits of their labor, it will be found that the national system of popular education in the United States fails entirely in accomplishing its mission, in several important particulars. For example, in the public schools our youth are, as a rule, entirely untaught in even the rudiments of industrial occupations, and upon passing from the school-room are generally utterly incompetent, unassisted, to earn a livelihood in any trade or pursuit requiring manual dexterity. Even our high-schools leave their graduates to drift, by accident or unintelligent direction, into vocations generally foreign to their abilities, and, as a rule, with few exceptions, unequipped with that character of knowledge or expertness without which a comfortable living becomes difficult—prominence impossible. It is commonly accepted as a fact that a good elementary education, such as is afforded by our public-school system, gives a child that which will carry it well along in life; but this is true only of agricultural, or at most of sparsely settled districts, and is then true only within limitations. The tendency of the system is—by elevating pupils above their actual or probable stations in life, and prompting in them desires and aspirations of which there is little chance of fruition—to turn out a large class of consumers, who fail utterly of success in the professions and kindred occupations, under conditions which, had their efforts been directed to mechanical or other industrial pursuits, would have made them efficient producers. A remarkably small percentage of our public-school graduates in the Middle and in the Southern States engage in any kind of manual labor.

Recognition of this lack of utility in our educational system has, of late years, become quite general, resulting in efforts to ingraft upon our higher-grade institutions industrial and scientific instruction, and the colleges and schools whose curricula embrace those subjects which fit our boys and girls to participate in the practical work of life are now rapidly increasing. There have long existed in the United States a certain number of educational institutions wherein special attention is given to technical and scientific training in mining, civil and mechanical engineering, applied mathematics, physics, and the natural sciences, which are fully equal to the best of similar schools in Europe. Among the most prominent of these are the School of Agriculture and Mechanical Arts of Cornell University, the School of Mines of Columbia College (New York), the Massachusetts Institute of Technology, the Lawrence School of Science in connection with Harvard University, the Pardee Schools, the Stevens Institute at Hoboken, the Rensselaer Polytechnic Institute, and the Sheffield School at Yale; but the high tuition fees charged by these and similar schools make instruction therein available only for the wealthier classes. Elementary science is also now taught in numerous colleges, academies, and high-schools. But, while this instruction, in point of cost and preliminary educational qualifications, is generally within the reach of the masses, the subjects taught and, as a rule, the manner of teaching them, have but little practical bearing on industrial pursuits. However, in the last few years considerable progress has been made in introducing a substantial help to industrial education — that of manual training-schools—and already their feasibility and desirability as a feature of popular education have been practically demonstrated. Well-equipped schools of this character are to be found in St. Louis, Chicago, Toledo, Philadelphia, and Boston.

The secret of the popularity of this kind of education is to be found in the natural and practical combination it makes of intellectual and manual training. Both thought and action are developed equally, and the skill acquired at school, together with the respect for industrial pursuits there fostered, makes their pupils useful, wealth-producing citizens.

It is undeniable that our national prosperity has been greatly promoted by the pre-eminence of certain of our manufactures in the markets of the world ; but our success in this respect has been due not to the superior intellectual cultivation or manual skill of our native artisans, but to very different causes, which we may regard as, in comparison, accidental ; and it is sad to reflect what greater success might have been achieved by combining with these causes that high degree of intelligence and skill that European nations are cultivating in their industrial classes. While the value of our great workshops as practical technical schools may be admitted, the ordinary workshop does not yet combine mental instruction with manual training. At the same time, our science-teaching is of too high a grade to be assimilable by the ordinary mechanic and mechanical apprentice, and is too theoretical to be adaptable to the current work of the shops. There is too little application of science to our handicraft, and a lack of intelligent effort to teach apprentices in our workshops the mechanical dexterity which they are supposed to acquire there. Now that the old system of apprenticeship is becoming obsolete, the question of what shall take its place in the way of educating and training the youth of our working-classes becomes an important consideration.

Provision for teaching mechanic-trades was attempted in the organization of the agricultural colleges, but most of these institutions have drifted away from the original intention of the authors of the act, and there is in them, generally, little or no effort to combine theoretical instruction with practical mechanical training in other than those branches of knowledge closely related to agricultural pursuits ; and much remains to be done before they can be of any material advantage to manufacturers and others requiring skilled labor. Our privately endowed schools do this work more directly and efficiently, but not as perfectly as they ought. Our university special departments, and our technological schools, even aggregated, are insignificant in number, and in most of them instruction in the mechanical arts has not been strictly adhered to, having been obscured by the literary and art-science sides of education. That this tendency is a very grave danger in technological schools generally, is very apparent from a study of those in England, where most of the institutions established purely and simply for technical instruction are already drifting into devotion for the higher branches of the natural sciences and mathematics, to the exclusion of drawing, applied science, and mechanical teaching. Judge MacArthur says that while we have schools for all sorts of instruction in mathematics, history, literature, and philosophy in abundance, they fit nobody with either knowledge or skill in any particular branch of industry. There is even a tendency in them to beget dislike for those pursuits that require manual labor. Our national system of elementary education is also drifting to the literary side, and tending to beget a distaste for manual work and industrial pursuits in general. Among the defects charged against existing provisions for industrial training, are that the instruction is too expensive for work-people; that the conditions of admission are too advanced for the mass of the people; that the instruction in most of the schools is too theoretical; and that, for the lack of evening instruction, the masses of mechanics who are compelled to labor during the day are debarred from availing themselves of their advantages, such as they are.

A dark-shadowed picture is drawn of the condition of the trade and the manufacturing industries of Baltimore. The former has declined in an alarming degree, and the latter have never been developed to any notable extent. Facts are presented bearing on some of the particulars of these categories, and evidence is given from which the conclusion is deduced that the manufacturing arts of the community are languishing as much for the want of skilled and intelligent artisans and managers to direct their operations, as from the lack of capital, cheap raw material, or natural facilities for production.

Johns Hopkins University, from which much might have been expected, lacks departments for training in practical industries. "With an income of $225,000 a year," says Mr. William Mather, an English observer of our schools, "it would appear possible for a larger amount of work to be done by this university among the people of the city, without in any degree diminishing the high class of instruction in the advanced stages of literary and scientific study."

In no field is more room afforded for the application of such skill and knowledge as technical training gives, than in the management and operation of railroads. Railroading has, in fact, become a profession, fully as exacting and requiring as high degrees of professional skill and intellectual attainments as the liberal professions. Yet Dr. Barnard has failed to find that "any of our railway managers have a proper appreciation of the situation, or that there has been any well-digested effort in the direction of educating railway officials or employés upon systematic lines, such as, for example, produce at West Point and Annapolis corps of young men whose basic education and training, with a little experience, fit them for any position of responsibility and trust in our military and naval service. Unquestionably there must be in many of our large railway organizations those who have long recognized the need of, and would warmly welcome, this educational factor in railway management, and doubtless many of them are, from previous education and long experience, peculiarly qualified for making a forcible presentation of the advantages of—and in view of the great changes that scientific discoveries are making in methods of production and transportation, and the new industries that are continually springing up, I may say the absolute necessity for—a combination of scientific and technical education for the operatives of the transportation service of the country. But, unfortunately, men of this type are, as a rule with few exceptions, overtasked with responsibilities and harassed with anxieties that leave few opportunities and little inclination for expressing their views on any subject foreign to their specific duties."

In the same ratio that our extensive railway system surpasses all other branches of industry in the magnitude of its business, the number of its departments and the interests affected, is there greater need for economy of administration and greater necessity for the application of the highest obtainable scientific knowledge and manual skill to its various operations. It has become the almost universal practice of our great railway corporations, and especially those whose lines are reaching out into undeveloped and sparsely settled territory, to assume the entire repairs of their plant, even when they amount to practical reconstruction, and there is also a steady tendency on the part of such companies in the direction of manufacturing their own equipment from raw materials. This places them in the category of manufacturers, and makes them amenable to the laws and factors regulating production. Because of the nature of their service, involving the transportation and care of many lives and valuable property, no less than as a matter of economy, is it of prime importance to such corporations that, in the construction and in the repair of their rolling-stock and appliances, they should employ workmen of exceptional competency.

Railroad enterprise is a comparatively new thing in the world's history, and its development has been sudden. Men trained to carry on the work could not easily be obtained. They were picked up where they could be found; lacking scientific training, they were naturally guided by "rule-of-thumb" practice, and their lives were sure to be narrowed, till they acquired a pride in being known as "practical" men. These men naturally transmitted their narrowness of knowledge and skill to their apprentices; and thus has been developed the average railroad workman of to-day. Many of our railroads employ armies of people, all of whom are supposed to be technically expert in their various vocations; but it is a well-known fact that in many railroads only one or two men in a road-gang know how to tamp a tie so that it will not require resetting the same season; and extensive lines are known to the author that do not possess a foreman—perhaps not a supervisor—who can adjust a curve with instruments. In these extensive enterprises the efficiency of the unit—the individual workman—becomes an item of grave economic consideration; for if it be true that the value of the individual's work (whatever it be) is increased through greater intelligence and special training, though it be only by a few cents per day, the total is of no inconsiderable moment, when his services continue through a series of years, and when, instead of one workman, thousands are employed. If even a slight deficiency in the skill and intelligence of one workman makes a few cents' or a few dollars' difference in the cost of the products of each week's labor; if the incompetency of one foreman or one manager lacking scientific training does usually—as so positively stated by competent authorities—net an appreciable loss; multiply the result to corporations like, for instance, our Eastern trunk-lines (one of which employs at least fifty thousand people on that part of its system east of the Ohio River, and more than half as many more west of it); realize that in such extensive organizations few if any of the practical details of the operating departments can be accurately gauged by those whose interests are most vitally concerned; comprehend how many important matters, involving grave consequences in their execution, must be intrusted to superintendents, master-mechanics, and foremen; then obtain a correct measure of their education and general knowledge (to say nothing of their scientific attainments), and we shall begin to appreciate the importance and bearing of this question of technological education, and the enormous losses the lack of it yearly entails upon investors in railway securities.

In railway service there is frequent necessity for sending to a distance, and beyond supervision, one or more thoroughly competent men, who shall not be simply mechanics, in the ordinary acceptation of the term, but who shall be able to turn their attention to work coming under their notice, whether they have before done that thing or not. At present such men are rarely found enrolled in the rank and file of railway mechanical departments; yet it is testified by many manufacturers who have afforded their operatives the advantages of technological instruction, that they have no difficulty in filling such positions with boys of twenty or twenty-one years of age, whom they send long distances and place in their hands work with which they have had little or no previous acquaintance, and by their intelligence they not only give the greatest satisfaction, but frequently develop into competent teachers of others.

The reason for the educational deficiencies of railway operatives is apparent when we consider how few opportunities they have for acquiring theory and practice in the same place and at the same time. The chasm between our schools and our workshops is not bridged, and consequently manual skill and intelligence remain divorced. All our higher schools, and even our technological schools, turn out students who are well up in theory, but deficient in practice. It is at the same time difficult to procure at any price men who combine superior skill, comprehensive mechanical knowledge, and general intelligence in such proportions as to make them valuable as foremen, managers, and specialists in mechanical pursuits or in the operating branches of railway service. Graduates of technological schools, when introduced into these positions, are apt to continue to show themselves more theoretical than practical. This constitutes an objection to depending on men of this class. The Pennsylvania Railroad pursues the plan of exacting of the graduates of technological institutions entering its service a novitiate in the construction and repair shops at Altoona before they are permitted to enter active service. Many young graduates of technical schools so highly value the opportunity of studying the scientific methods and enjoying the instruction of the Altoona shops as—it is said—to disregard pecuniary compensation, in a wise desire to avail of the fine training obtainable there. At the same time, this instruction is believed to be neither so specific nor so thorough as it should be.

"Many of the discoveries of the day are not used because workmen do not understand them, or are incompetent or unwilling to utilize them, and there is also an acknowledged deficiency in the ability of railroad employés to determine, with scientific accuracy, the shapes and dimensions which are best adapted to stand the strains of the various working parts of the locomotives and other machinery used by railroad companies. Though much has been done in this direction by specialists, it is more than probable, from their testimony and from the deficiencies of such machinery, that scarcely a tithe of the facts that may and ought to be known in this matter are yet discovered, or, where known, availed of. Such investigations, owing to the scarcity of men combining both practical and theoretical knowledge, are so costly and uncertain, and require so much skill and technical training to conduct them, that manufacturing companies can not often afford to hire specialists or bear the expense of experimenting; but in a school connected with railway-shops, under competent guidance and instructors of ability, much may be done, as a part of the school and shop-work instruction, that will, at the same time, accomplish desirable results in other fields. It is the testimony of many of our best educated engineers that the engineering profession in all its departments is continually hampered by the want of more extensive and more accurate experiments. They say that 'in far too many matters they have nothing to rely on but the imperfect or imperfectly reported results of antiquated experiments.' The difficulty is, that most of their experiments and observations have necessarily to be of short duration, and that they have insufficient data upon which to base their conclusions. If, now, we can introduce the scientific method of original research and experiment into our workshops; if, instead of one experimenter, there may be dozens of wide-awake, observing, and energetic men in search of scientific and mechanical truth; if, instead of one experiment at a time, there may be several under different circumstances going on at the same time; if, instead of continuing a single day or a single week, these experiments in the workshop may be continued through months and even years; if, in other words, our workmen, or a large number of them, can be taught to regard the workshops themselves as great laboratories for continued research, experiment, and observation with a view to gaining original information for practical purposes—then there need be no more complaint in the realm of applied science about inadequate data and uncertain conclusions."

This system would also furnish a stimulus to invention and improvement and to the adaptation of economical devices. The importance of technical training is so well recognized among European manufacturers that many employers are said to be in the habit of sending to home and foreign exhibitions, at their own expense, those of their young people most advanced in technological study and of quickest perceptions, in order that they may study new inventions, machinery, etc.; while many others allow their apprentices and young men to leave their work an hour or more before stopping-time, on class-nights, without abatement of their wages. Many European manufacturers and the managers of some foreign railway-works now call the particular attention of their workmen to new designs, improvements in machinery, and methods of work, and to successful inventions that have been made by other workmen trained in technical schools. Such workmen can not fail to become constantly on the alert for opportunities to accomplish something above the performance of mere routine duty; whereas, lacking scientific knowledge and technical training, they would probably be contented to go on in the old paths of routine, and might even oppose improvement.

Among other advantages of technological schools adapted to the wants and standard of the workmen who are to attend them are, that they will do much to prevent and overcome labor troubles, which often arise through misunderstandings that the instruction given by such schools and their influence would anticipate; that their effect will be to diminish the tendency to dissipation among the workmen, and increase their efficiency; and that, by providing useful and congenial employment for the leisure time of apprentices, they will, promoting good habits and discouraging the formation of bad ones, have an especially beneficial effect upon their future. Workshop-schools have the further advantage over others that, giving easy access to machinery, and directly applying the principles and theory learned in the school-room to work in the shops having a commercial value, they would make their instruction practical in a high degree. They are also especially valuable for training the young of our industrial classes, because the pupils are thereby enabled to earn a livelihood while acquiring theoretical and practical knowledge as they go, each supplementing and assisting the other.

Whatever the Baltimore and Ohio Railroad has achieved in the way of commercial success has not resulted from superior skill or intelligence of its subordinate officers or of the rank and file in its several departments, but rather in spite of their deficiencies. The company has been fortunate in one sense, in that the geographical isolation of its main stem and branches has contributed to the gradual formation of a corps of operatives who, by descent, tradition, and personal attachments, may be said to belong to the road. From their earliest youth they have looked forward to an active participation in the operations of the line as a means of livelihood, and all their aspirations and ambitions are associated with its service. This condition has been fostered by the custom of regarding the children of meritorious operatives as entitled to prior consideration in making appointments. While this has resulted in creating and maintaining a corps of operatives of exceptional devotion and loyalty, and has in many other ways been advantageous to the service, it has also in some ways that were unforeseen proved prejudicial to the company's interests. Thus, the inhabitants along the main-stem divisions are destitute of educational facilities, and this, coupled with the sense of proprietorship in the positions and the idea that education beyond the bounds of his trade is of no practical use to a mechanical workman, has created indifference on the subject. This was one of the considerations which prompted the establishment of the school at Mount Clare. Of the first class of boys examined for admission to the school, only forty were found in such a condition of discipline and grounding in the common English branches as to justify the hope that they could enter upon the course for graduation as mechanics, and not one of them was capable of entering upon the higher studies necessary to qualify him for an officer's position in the service. It being thus manifested that there was no material from which to manufacture efficient officers, nor was any likely to be acquired under the then existing system, a general order was issued promulgating regulations for the future admission of apprentices, and prescribing the minimum qualifications of candidates, which, while neither onerous nor of a high grade, provided a sufficient foundation for the technical instruction necessary to make a fairly educated mechanic. In the same general order the lines upon which the educational work was to be conducted were defined in general terms. The plan outlined in that order contemplated.

1. Instruction (in the apprentice class of such boys as could pass the examination therein indicated) of a character that will make them

skilled and intelligent mechanics. While this first-class course would naturally lead up to the second or cadet class, it should provide within itself all the elements of technical instruction necessary to complete a journeyman's education.

2. A second or cadet course, which should also be complete within itself, and should provide such technical instruction in all the departments of railway service as would fit its students for all subordinate positions of responsibility and trust in the service, corresponding to what is known in European schools as the foreman's course of study. This course, while involving more thorough and wider theoretical instruction than the apprentice course, should, to the greatest extent possible, be framed with reference to the practical mechanical operations of the shops and of the service generally.

3. A third or cadet officers' course, the object of which will be to give to those who graduate with honor from the second class (and who have therein shown themselves possessed of ability and educational qualifications above the average) further technical training, of a still higher and more comprehensive type, which, when combined with familiarity with the operations of the various departments of the service, will go far toward qualifying the students of that course for the highest positions in the company's gift. To this end, opportunity should be afforded the pupils of this course, in its last year, to actively participate in the production, care, repair, and improvement of railway plant and in the practical operations of the service. This could readily be done—and with advantage to the service also—by distributing these students among the several departments as assistants, at the same time maintaining their connection with the school for further educational purposes. This course is not yet in operation.

In the apprentice course, school-instruction should be made secondary to shop-work, while in the higher courses shop-work should always be secondary to mental training.

Although these provisions relate especially to instruction in Baltimore, the plan has been drafted in a more general sense, and contemplates the gradual extension of this educational movement over the entire system of the railroad. While Baltimore will always be the center of such a movement, no great difficulty is apprehended in extending the apprentice course, at least, over the entire road, by establishing night-schools for drawing, mathematics, and elementary science, or securing the introduction of the boys into such schools as are already in operation, and the modification of their curriculum in the manner indicated.

Prior to the establishment of school-work at Mount Clare, the Baltimore and Ohio apprentices had neither incentive nor opportunity to develop into intelligent workmen, so that on starting the classes it was with great difficulty and only by absolute compulsion that the attendance of about forty shop-boys was secured. They were, with few exceptions, rude and almost unmanageable in the class-room, uninterested in the instruction, and scarcely able to await the hour of dismissal, when they would vacate the school-room rudely and in haste. Then the class-instruction was confined to the most elementary subjects, and the boys were unable or unwilling to read technical or scientific books with any show of profit. Now there are under school-instruction seventy-five as orderly and polite boys as are to be found in any high-school of the country, and among the very best of them are boys who a few months ago were conspicuous for rudeness and insubordination. There have been classes of apprentices in geometry, algebra, physics, locomotive-engine, mechanics, mechanical drawing, free-hand drawing, geometrical drawing, English and history, and a valuable method of instruction by special reading, selected and recommended by the teachers to each pupil, with special reference to his talents and the state of his education.

Last year, as a rule, boys had to be compelled to take up algebra and geometry ; at this time many are promising promptness, regularity, and other inducements to secure admission to those classes, and a number have become very urgent for the higher science and mechanical studies. Many of these boys regularly spend their noons studying works in science and mechanics, going from shop to shop and from machine to machine, studying the principles involved in their construction and operation. Every examination for apprentices brings in a better class of applicants ; as the result of which the standard upon which admission to the service is predicated is being gradually raised.

It may be added that the practical result of this report has been to induce the Board of Directors of the Baltimore and Ohio Railroad Company to make a permanent appropriation of $20,000 annually for the conduct of this school, and that Dr. Barnard is now engaged in the preparation of plans for what will be the first technical railroad-school ever established in the United States.

## GRAINS OF SAND.

By GEORGE WARDMAN.

THE manufacture of sand is an important industry, which has Pittsburg for its headquarters, although the sand is not made within the limits of the city. There is a considerable traffic in Monongahela sand, which is scooped up from the bed of the river, to be used for common building purposes ; but the manufacture of sand is quite another affair, and the product goes into quite a different commodity, which is glass.

Practically glass is almost pure sand, other substances used in its manufacture for fluxing being consumed while the sand is transformed to a greater or less degree of transparency. The sand used in glass-making is almost pure silica, so nearly pure that there is less than one per cent of iron, magnesia, and aluminum, to ninety-nine + per cent of the other. And of this sand, which is quarried out of the hills and ground down to varying degrees of fineness, and washed to varying degrees of whiteness, eight hundred tons are manufactured daily, four hundred tons being consumed in and about Pittsburg, and four hundred tons going into Eastern Ohio and West Virginia to Wheeling, Bellaire, Columbus, and all points within a circuit of one hundred and fifty miles from Pittsburg.

In selecting, a darkish sand is found, containing more foreign substances than the ninety-nine per cent silica, which inferior grade goes into green or "black" bottles, and a still darker and baser earth, which is used for sanding fire-brick molds; another and finer dark grade, which is used by crucible-steel manufacturers; and still another quality, the whitest and grittiest, which becomes "flint," or what might be called absolutely transparent glass. An inferior quality of white sand is used for prescription-bottles, but the very best is for the higher grade of flint-ware.

Looking through the flat surface of window-glass, whether plate or blown, it appears colorless; but, if the sight is directed through the edge, it will disclose a sea-green tinge. Flint-glass proper is not so. It is absolutely colorless, except when cut into faces or prisms, when it reveals the colors of the spectrum.

The cost of a ton of sand to glass-manufacturers of Western Pennsylvania, Eastern Ohio, or West Virginia, is, of course, dependent on the distance it is hauled from the quarry; but, taking the eight hundred tons daily manufactured and consumed, it will not average above $2.25 per ton, damp. Dried sand will average $2.50 per ton. Of course, it costs a little less than those figures in Pittsburg, and a little more in Bellaire, Ohio; but even at this last-named place, the cost of the sand which goes into the manufacture of a box of common window-glass, containing the regulation fifty square feet of surface, is about five cents; that is, the box of glass consists merely of five cents' worth of silica, transmuted to a state of transparency.

The sand used in the glass industry in Western Pennsylvania, Eastern Ohio, and West Virginia, comes from three quarries: one on the Pennsylvania Railroad, overlooking the Juniata; one on the Baltimore and Ohio Railroad, near Connellsville; and one on the Pittsburg, McKeesport, and Youghiogheny Railway, twenty-five miles south of Pittsburg. It is quarried out like building-stone, passed through a quartz-crusher, further reduced under immense iron wheels, and finally ground and washed in an endless screw. The washing releases some of the foreign substances, but streaks of iron which are sometimes found running through the stone are knocked off to undergo the milling process for the inferior quality of sand, some of which goes into mortar for specially fine and durable wall-building. The railroads use large quantities of it in the construction of retaining-walls for embankments. And so all grades of the sand are utilized.

## APPEARANCE AND REALITY IN PICTURES.

By Dr. EUGEN DREHER.

IN the contemplation of the creations of the painter, the mind is stimulated to a degree of activity which the enjoyment of no other form of art-work can induce. A mental operation is provoked of which we are hardly conscious, and which some have attributed to the organization of the visual apparatus, that amounts in effect to the transformation of the flat surfaces of the picture into the appearance of a body or a group standing out or receding in relief. The inquiry as to how the painter can invoke this illusion is usually answered by saying that he knows how to represent objects in perspective; that is, that he is able to arrange the lines of the picture—except that the image is not reversed—so that the adjustment shall correspond essentially with that of the image which is cast upon the photographer's screen or upon the retina of the eye. The process, unperceived and instantaneous in the case of simple objects, by which such representations are given bodily projection, may be followed out in its gradual development in contemplating pictures of a more complex character, as, for instance, a view of the interior of a grand cathedral. Without any change taking place in the image on the retina, the individual objects are gradually lifted one from another; those represented as in the background appear to become larger but at the same time obscure, and those in the foreground to grow smaller but more sharply defined. Thus the size we attribute to the objects depends upon the distance we assign to them as well as on the visual angle they subtend. There are, according to this, unconscious processes that fit us for seeing plane surfaces as bodies, provided the picture furnishes suitable points to which our conceptions of corporeal projection may attach themselves. To see a perspective representation of a cube, I must have remaining within me a conception of a cube already acquired by the exercise of my senses; and, without such an acquired conception, the picture would still be to me only a picture or a planimetric feature, without projection. Hence we find that, in looking at pictures, unconscious representations intrude upon the primary conceptions, and change them into secondary ones, by means of which a surface is made to look like a body having projection. This process occurs in all monocular vision, when we interpret the flat retinal image corporeally.

To obtain a proper appreciation of a perspectively correct picture, we must look at it with one eye; for, in looking with two eyes, the duplication of the visual lines that define the position of each point as it is perceived, must cause more or less of the impression of the really plain surface to persist. In this case the corporeal projection becomes confused with the superficial conception, and is more or less modified by it. The effect of perspective is also heightened by looking at the painting through a tube, by means of which it is abstracted from the frame and from its surroundings.

We observe, also, in looking at a picture, the curious phenomenon that, whatever position we may take toward it, it always appears projected, but in aspects which are varied not only in respect to the absolute position of its constituent parts, but also in respect to their mutual relations with one another, to such an extent that from an extremely unfavorable position it appears distorted.

Whenever an artist can not produce the perspective effects he desires in a picture drawn with absolute correctness, he does not hesitate to exaggerate the perspective if he thinks he can thereby enforce a better conception of his design. He represents distant objects on a smaller scale than strict accuracy demands, and causes us, by unconsciously taking account of the reduction, to see them farther off than we otherwise would do; and he knows how to call our imagination to his help in other ways.

Although the application of perspective devices is usually enough for the purpose, the projection of the design is heightened to a considerable degree, facilitated and brought nearer the appearance of reality by the introduction of effects of light and shade. This also is borrowed from Nature. The shading may, indeed, sometimes define and fix the effect which mere perception fails to convey positively. A square with two diagonals drawn across it may mean simply that, or it may be intended to represent a pyramid. If proper shading is added, the figure is made to mean a pyramid unmistakably.

If we assume that the light is evenly diffused through any space, then, other conditions being equal, those things in the space which are nearer to us will be clearer in appearance in a proportion determined by the rule that the intensity of light diminishes as the square of the distance increases. A point twice as far from the eye as another appears four times as obscure. This normal diminution of intensity is augmented by the darkening which objects undergo in consequence of the interposition of strata of air, or by the effect of "air-perspective," as it is called, in distinction from linear perspective. The painter must take both of these phenomena into account. By the application of a suitable coloring, the effect of air-perspective may be produced in so striking a degree that objects may, by means of it, be made to appear wonderfully remote. This effect, also, is dependent upon our unconscious application of knowledge we have gained from previous experience.

The shadow which all objects cast when exposed to any kind of light is a capital sign of bodily substance. Our conception of bodies is inseparable from that of their shadows. The importance of this phenomenon as an aid to projection is illustrated by the manner in which through them flat letters on signs are made to appear standing out as solid bodies.

The painter is also able to represent motion by taking advantage of the unconscious working of our preconceived impressions. Looking at a masterly marine landscape in the National Gallery at Berlin one day, I could almost see the ship rising and falling upon the waves, and the waves themselves seemed to be in motion as they swelled and swept by the vessel. The painter had seized a single instant in the succession, and had so represented it as to call out the idea of consecutiveness. The question arises, How is the artist to illustrate motion, as he often has to do, say in such a case as that of a rapidly turning wheel, in which we can at no instant distinguish the single spokes, but see only a confusion of flying lines? It is clearly impossible for him to give the exact appearance of motion. He can only seize a given instant or stage, and so manage that it shall represent itself as the effect of the preceding stage and the cause of the following one: A sword-blow must be represented at a decisive point, not at a stage in the descent of the weapon, else the illusion will be destroyed; a pendulum in motion, not at the bottom of its course, where it would seem to be at rest. In painting a galloping horse, no stage of the exact motion is reproduced. The instantaneous photographs have demonstrated that; and also that, if the artist should attempt a reproduction of the kind, he would give any but the effect desired. He makes a more pleasing and probable picture, having, however, no counterpart in Nature, in which he does no violence to her, but, as Schiller has said, "increases the nature that is in Nature."

The theory of color-perceptions is not yet far enough advanced to permit a full explanation of all the phenomena of coloring; still, it is competent in its present condition to give valuable hints concerning the color-effects experienced in the contemplation of paintings.

All the variations in color perceived in Nature may be produced from red, yellow, and blue, or, as others have it, from red, green, and violet, and their combinations. The painter does not possess any of these colors in their purity, but always adulterated with more or less that is foreign to them, and can hardly ever reproduce the exact color he finds in Nature, and it is his task to combine the materials he has so as to give as near as possible an approach to them. How does he, with the deviations he is forced to make, bring about the magic illusion that causes us to perceive in his creations the same endless play of light and color that Nature so lavishly bestows upon her pictures? How does he reproduce the burning glow of the setting sun and the objects it illuminates? He does it by means of a contrast of colors, in which particular shades are given a changed appearance to our perceptions by backing them one against another. When, for instance, a tolerably clear red and a tolerably pure green are put together, both colors appear to undergo a change, and to gain in purity ; or, in popular language, the red seems to become redder and the green greener. This proceeds from two causes, one of which is purely mental, and consists in the heightening of the contrast between the two colors when they are brought into comparison with each other ; while the other is physical, and depends upon a kind of fatigue which the nervous fibers suffer in consequence of the higher activity which the presentation of the contrast develops in them. As the perception of the red becomes wearied, that of the green becomes more acute, and *vice versa*, and the two in this manner react upon each other. By a similar process, white reposing upon black appears clearer and purer, while the black seems deeper and darker.

A painter, having to introduce two kinds of light, daylight and candle-light, into his picture, would not be able to represent directly the contrasts which the struggle between the two kinds of light calls forth in Nature, because his colors are so inferior in intensity to the reality. He has to paint the effect in by making the daylight relatively bluer and the candle-light more of a red-yellow than in Nature. He thereby leads us, after an interval, to an illusion of the same character with that which Nature, by the superior intensity of its light, produces in a moment.

In like manner, the painter, by exaggerating the illumination of his objects, reproduces similar effects to those which Nature gives with the full brilliancy of its light ; as, for instance, the glow of the snow-fields of the Alps, which the beams of the evening sun clothe as with a garment of fire, in contrast with the dark-blue vault of the sky above them, and with the valleys already hiding themselves in the shadows of night. In all these cases the action of Nature is made more speedy than that of the picture, because the light at its disposal is so much stronger, but the effect of both is in the end of the same character, and the seeming becomes clothed with reality.

The painter must, furthermore, give effect to other color-perceptions which are wholly conditioned upon the organization of the eye. These are the subjective conceptions that show forth the complementary colors. By this term are meant those colors which in combination produce white, as red and green, blue and orange, yellow and violet. The complementary tint also appears after the eye has become fatigued in looking at a particular color, as when the eye has been gazing at green, it turns to a white spot and appears to see it red.

The complementary effects may frequently be observed in Nature. Parts of the sky between bright-red clouds sometimes appear green ; and the ground of a wood, the bright-green foliage of which glitters in the sunlight, looks rose-colored. The painter has to take these phenomena into consideration, and, making due allowance for the weakness of his pigments, to incorporate the apparent tints into his picture. Here, again, what Nature with her vivid colors does in an instant, the artist has to bring about more slowly ; but the illusion is complete in both cases from the moment our conceptions are brought into accord with it.

There is, furthermore, something in the colors of natural objects which is distinct from the strength and clearness of the illumination, and appears peculiar to certain kinds of light. Among such peculiarities are the metallic luster, the silken sheen, and opalescence, which, although they all proceed from combinations of the spectrum-colors, have not yet been sufficiently investigated to enable us to determine all the circumstances contributing to produce them.

The colors used in painting afford little that is analogous with these lusters. Can the painter produce these effects also by contrast ? They appear in pictures by the most eminent masters to be reached almost in perfection. If, however, we inquire whether the painter can reproduce the peculiarities of luster and color which we admire so much in Nature through the contrast of his colors alone, we shall have to admit that he calls other elements into play.

We have already shown how our conceptions of the relations of objects in place are influenced by our unconscious prepossessions. May not these also intrude themselves upon and modify our conceptions of the color and tone of the picture ? The connoisseur who has frequently observed the shimmer of the sea, and who has followed with a finely developed perceptive power the transformations of the landscape under a changing light, and who has been in the habit of watching in an æsthetic mood the combination and grouping of the individual features of Nature, is doubtless better able to realize these peculiarities also in works of painting, than he who applies only a sharp but untrained discernment to the gradual development of the idea of the picture.

Thus art, temporarily withdrawing us from Nature by substituting her own creations for the reality, brings us back to Nature as the inexhaustible source whence all its elements are borrowed ; and the imagination, also, in its own way, is able to make use of those elements for new creations.—*Translated for the Popular Science Monthly from Die Natur.*

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Colonel Serpa Pinto and Lieutenant Cardozo last year made a successful scientific exploration of the lake-region of Africa. They made a geodetic triangulation of the country from Ibo to Lake Nyassa, whence Lieutenant Cardozo—Colonel Pinto having withdrawn on account of illness—went to Shirva and Blantyre, and by a new road to Quilimane. This is the first scientific work of the kind done in that part of Africa.

# AMONG THE TRANSYLVANIAN SAXONS.

## BIRTH AND DEATH.

[*Concluded.*]

BY-AND-BY, when a few months have passed over the head of the new-married couple, and the young matron becomes aware that the prophecies pointed at by the doll's cradle and the broken distaff are likely to come true, she is carefully instructed as to the conduct she must observe in order to insure the well-being of herself and her child.

In the first place, she must on no account conceal her state, or deny it when interrogated on the subject—for if she do so, her child will never learn to speak; nor may she wear beads on her neck, for that would cause the infant to be strangled at its birth. Carrying peas or beans in her apron will produce malignant eruptions; and sweeping a chimney will make the child narrow-breasted.

On no account should she be allowed to pull off her husband's boots, nor to hand him a glowing coal to light his pipe; for both these actions bring misfortune. In driving to market she may not sit with her back to the horses, nor may she ever drink at the well out of a wooden bucket.

Also, her intercourse with the pig-sty must be very carefully regulated; for if she listen too attentively to the grunting of pigs, her child will have a deep, grunting voice; and if she kick the swine or push them away with her foot, the infant will have bristly hair on its back. Hair on the face will be the result of beating a dog or cat, and twins will be the consequence of eating double cherries or sitting at the corner of the table.

During this time she may not stand godmother to any other child, or else she will lose her own baby, which will equally be sure to die if she walk round a newly made grave.

If any one throw a flower suddenly at the woman who expects to become a mother, and hits her with it on the face, her child will have a mole at the same place touched by the flower.

Should the young matron imprudently have neglected one of these rules, and have cause to fear that an evil spell has been cast on her child, she has, however, several very efficacious recipes for undoing the harm. Thus, if she sit on the door-step with the feet resting on a broom for five minutes at a time on seven consecutive Fridays, thinking the while of her unborn babe, it will be released from the impending doom; or else let her sit there on Sundays, when the bells are ringing, with her hair hanging unplaited down her back; or else climb up the belfry-tower and look down at sunset on to the landscape below.

When the moment of the birth is approaching, the windows must be carefully hung over with sheets and cloths to prevent witches from entering; but all locks and bolts should, on the contrary, be opened, else the event will be retarded.

If the new-born infant be weakly, it is usual to put yolks of eggs, a glass of old wine, bran, or sawdust into its first bath.

Very important for the future luck and prosperity of the infant is the day of the week and month on which it happens to have been born.

Sunday is of course the luckiest day, and twelve o'clock at noon, when the bells are ringing, the most favorable hour for entering upon life. If a Sunday's child have its fingers rubbed with oil on every seventh birthday (7th, 14th, 21st, etc.), it will henceforward be able to perceive underground treasures through its transparent finger-tips.

Wednesday children are *Schlabberkinder*—that is, chatterboxes; Friday bairns are unfortunate; but in some districts Saturday is yet more unfortunate, while in other places they are merely supposed to grow up dirty.

Whoever is born on a stormy night will die of a violent death.

The full moon or growing moon is favorable, but the decreasing moon will produce weakly and unhealthy babes.

All children born between Easter and Pentecost are more or less lucky, unless they happen to have come on one of the distinctly unlucky days, of which I here quote the most important. These unlucky days are:

January 1st, 2d, 6th, 11th, 17th, and 18th.
February 8th, 14th, and 17th.
March 1st, 3d, 13th, and 15th.
April 1st, 3d, 15th, 17th, and 18th.
May 8th, 10th, 17th, and 30th.
June 1st and 17th.
July 1st, 5th, 6th, and 14th.
August 1st, 3d, 17th, and 18th.
September 2d, 15th, 18th, and 30th.
October 15th and 17th.
November 1st, 7th, and 11th.
December 1st, 6th, 11th, and 15th.

I leave it to more penetrating spirits to decide whether these seemingly capricious figures be regulated on some hidden system, the mystic workings of which have baffled my understanding; so that I am utterly at a loss to explain why January and April have the greatest number of unlucky days assigned to them, while June and October have the smallest proportion; and why the 1st and 17th are hardly ever harmless, while all days between the 18th and 30th are invariably good.

Both mother and child must be carefully watched over during the first few days after the birth, and all evil influences averted. The visit of another woman who has herself a babe at the breast, may deprive the young mother of her milk; and any one who enters the house without sitting down will assuredly carry off the infant's sleep.

If the child be subject to frequent and apparently groundless fits of crying, that is a sure sign that it has been bewitched, either by some one whose eyebrows are grown together, and may consequently be supposed to have the evil-eye, or by one of the invisible evil spirits whose power is great before the child has been taken to church; but even a person with quite commonplace eyebrows may convey evil by unduly praising the child's good looks, unless the mother remembers to spit on the ground as soon as the words are spoken.

I will here quote a few specimens of the various recipes in vogue for undoing such evil spells:

Nine straws, which must be counted backward from nine till one, should be placed in a jug of water, drawn from the river with the current, not against; into this are thrown parings of wood from off the cradle, the door-step, and the four corners of the room in which the child was born, also nine pinches of ashes, likewise counted backward. When all these various ingredients have been boiled up together, the water is poured boiling hot into a large basin, and the pot left in it upside-down. If the boiling water draws itself into the jug (as of course it will), that is proof positive that the child was bewitched; and the mother should moisten its forehead with the water before it is cold, and give it (still counting backward) nine drops to drink.

The child that has been bewitched may likewise be held above a red-hot plowshare, on which a glass of wine has been poured; or else a glass of water, in which a red-hot horseshoe has been placed, given to drink.

In almost every village there used, not long ago, to be old women who made a regular trade out of preparing the water which was to undo evil spells.

The Saxon mother is careful not to leave her child alone until it has been baptized, for fear of the malignant spirits, who may steal it away, leaving an uncouth elf in its place. Whenever a child grows up clumsy and heavy, with large head, wide mouth, stump nose, and crooked legs, the gossips are ready to swear that it has been changed in the cradle, more especially if it prove awkward and slow in learning to speak. To guard against such an accident, it is recommended to mothers obliged to leave their infants alone, to place beneath the pillow either a prayer-book, a broom, a loaf of bread, or a knife stuck point upward.

Very cruel remedies have sometimes been resorted to in order to force the evil spirits to restore the child they have stolen, and take back their own changeling. For instance, the unfortunate little creature, suspected of being an elf, was placed astride upon a hedge and beaten with a thorny branch until it was quite bloody; it was then supposed that the evil spirits brought back the stolen child.

The infant should not be suffered to look at itself in the glass till after the baptism, nor should it be held near an open window. A very efficacious preservative against all sorts of evil spells is to hang round the child's neck a little triangular bag stuffed with grains of incense, wormwood, and various aromatic herbs, and with an adder's head embroidered outside; a gold coin sowed into the cap will likewise keep the spirits away.

Two godfathers and two godmothers are generally appointed at Saxon peasant christenings, and it is customary that one couple should be old and the other young; but in no case should a husband and wife figure as god-parents at the same baptism, but each one of the quartet must belong to a different family. This is the general custom; but in some districts the rule demands two godfathers and one godmother for a boy—two godmothers and one godfather for a girl.

If the parents have lost other children before, then the infant should not be carried out by the door in going to church, but handed out by the window, and brought back in the same way. It should be carried by the broadest street, never by narrow lanes, else it will learn thieving.

The god-parents must not look round on their way to church; and the first person met by the christening procession will decide the sex of the next child to be born—a boy, if it be a man.

If two children are baptized out of the same water, one of them will soon die; and if several boys are christened successively in the same church, there will be war in the land as soon as they are grown up. Many girls denote fruitful vintages for the country when they have attained a marriageable age.

If the child sleeps during the baptismal ceremony, then it will be pious and good-tempered; but if it cries, it will be bad-tempered or unlucky; therefore, the first question asked by the parents on the return from church is generally, "Was it a quiet baptism?" and if such has not been the case, the sponsors are apt to conceal the truth.

In some places the christening procession returning to the house of the parents finds the door closed. After knocking for some time in vain, a voice from within summons the godfather to name seven bald men out of the parish. When this has been answered, a further question is asked as to the gospel read in church; and only on receiving the answer, "Let the little children come to me," is the door flung open, saying: "Come in; you have hearkened attentively to the words of the Lord." The god-parents next inquiring, "Where shall we put the child?" receive the following answer:

"On the bunker let it be,
That it may jump like a flea;
Put it next upon the hearth,
Heavy gold it will be worth;
On the floor then let it sleep,
That it once may help to sweep;
On the table in a dish,
It will grow then like a fish."

After holding it successively on each of these places, it is finally put back into the cradle, while the guests prepare to enjoy the *Tauf Schmaus*, or christening banquet.

Each person is expected to bring a small contribution in the shape of eggs, bacon, fruit, or cakes; and the god-parents do not fail to come each laden with a bottle of good wine, besides some other small gift for the child.

The banquet is a noisy and merry one, and many are the games and jokes practiced on these occasions. One of these, called the *Badspringen* (jumping the bath), consists in putting a lighted candle on a washing-trough, which is placed upside-down on the ground. All the young women present are invited to jump over without upsetting or putting out the light. Those who are successful in this evolution will be mothers of healthy boys. If they are bashful, and refuse to jump, or should they be awkward enough to upset the candle, they will be childless, or have only girls.

The *Spiesstanz*, or spit-dance, is also usual on these occasions. Two roasting-spits are laid on the ground crosswise, as in the sword-dance and the movements executed much in the same manner.

Sometimes it is the grandfather of the new-born infant who opens the performance, proud of displaying his agility as he sings:

> "Purple plum so sweet,
> See my nimble feet;
> How I jump and slide,
> How I hop and glide;
> See how well I dance,
> See how well I prance.
> Purple plum so sweet,
> See my nimble feet."

But if the grandfather be old and feeble, and if the godfathers can not be induced to exert themselves, then it is usually the midwife who, for a small consideration, undertakes the dancing.

It is hardly ever customary for the young mother to be seated at the table along with the guests; and even if she be well and hearty enough to have baked the cakes and milked the cows on that same day, etiquette demands that she should play the interesting invalid and lie in bed till the feasting be over.

For full four weeks after the birth of her child must she stay at home, and durst not step over the threshold of her court-yard, even though she has resumed all her daily occupations within the first week of her recovery. "I may not go outside till my time is out; the *Herr Vater* would be sorely angered if he saw me," is the answer I have often heard from a woman who declined to come out on to the road. Neither may she spin during these four weeks, lest her child should suffer from dizziness.

When the time of this enforced retirement has elapsed, the young mother repairs to church along with her infant to be blessed by the pastor; but before so doing she is careful to seek the nearest well and throw down a piece of bread into its depths, probably as an offering to the *Brunnenfrau* supposed to reside in each water, and who is said to lure little children down to her.

With these first four weeks the greatest perils of infancy are considered to be at an end; but no careful mother will fail to observe the many little customs and regulations which alone will insure the further health and well-being of her child.

Thus she will always remember that the baby may only be washed between sunrise and sunset, and that the bathing-water may not be poured out into the yard at a place where any one can step over it, which would entail sickness or death, or at the very least deprive the child of its sleep.

Two children which can not yet speak must not be allowed to kiss each other, or neither of them will ever learn to talk.

A book laid under the child's pillow will make it an apt scholar; and the water in which a young puppy has been washed, if used for the infant's bath, will cure it of all skin-diseases.

Whoever steps over a child as it lies on the ground will cause it to die within a month. Other prognostics of death are to rock an empty cradle, to make the child dance in its bath, or to measure it with a yard-measure before it can walk.

Death, to the Saxon peasants, appears in the light of a treacherous enemy, who must be met with open resistance, and may be conquered by courageous opposition or conciliated with a bribe. "He has put off death again with a slice of bread," is said of a man who has unexpectedly survived some great danger.

When the first signs of an approaching illness declare themselves in a man, all his friends are strenuous in advising him to hold out against it, not to let himself go, but to grapple with this foe which has seized him unawares. Even though all the symptoms of typhus fever be already upon him, though his head be burning like fire, and his limbs heavy as lead, he is yet exhorted to bear up against it, and on no account to let himself lie down, for that would be a concession to the enemy.

In this way many a man goes about with death upon his face, determined not to give in, till he drops at last senseless in the field or yard where he has been working till the last moment.

Even then his family are not disposed to let him rest. With well-meaning but mistaken kindness, they endeavor to rouse him by shouting in his ear. He must be made to wake up and walk about, or it will be all over with him; and not for the world would they send for a doctor, who can only be regarded as an omen of approaching death.

Some old woman versed in magic formulas, and learned in the decoction of herbs and potions, is hastily summoned to the bedside; and the unfortunate man would probably be left to perish without intelligent advice, unless the pastor, hearing of his illness, takes it upon himself to send for the nearest physician.

By the time the doctor has arrived, the illness has made rapid strides, and most likely the assistance comes too late. The first care of the doctor on entering the room will be to remove the warm fur cap and the heavy blankets, which are well-nigh stifling the patient, and order him to be undressed and comfortably laid in his bed. He prescribes cooling compresses, and a medicine to be taken at regular intervals, but shakes his head and gives little hope of recovery.

Already this death is regarded as a settled thing in the village, for many of the gossips now remember to have heard the owl shriek in the passing nights, or there has been an unusual howling of dogs just about midnight. Others call to mind how over-merry the old man had been four weeks ago, when his youngest grandchild was christened, and that is ever a sign of approaching death. "And only a week ago," says another village authority, "when we buried old mother Barbara, there was an amazing power of dust round the grave, and the *Herr Vater* sneezed twice during his sermon; and that, as every one knows, infallibly means another funeral before long. Mark my words, ere eight days have passed he will be lying under the nettles."

The village carpenter, who has long been out of work, now hangs about the street in hopes of a job. "How is the old man?" he anxiously inquires of a neighbor.

"The pastor has just gone in to knock off the old sinner's irons," is the irreverent answer.

"Then I may hope to be called in soon for making his coat (coffin). High time I was able to turn an honest penny again. I have a heap of damaged boards which were refused by the railway engineers still lying on my hands."

Sometimes, however, it is the thrifty peasant himself who, knowing the ways of village carpenters, and foreseeing this inevitable contingency, has taken care to provide himself with a well-made, solid coffin years before there was any probability of its coming into use. He has himself chosen out the boards, tested their soundness, and driven a hard bargain for his purchase, laying himself down in the coffin to assure himself of the length being sufficient. For many years this useless piece of furniture has been standing in the loft, covered with dust and cobwebs and serving perhaps as a receptacle for old iron or discarded shoes; and now it is the dying man himself who, during a passing interval of consciousness, directs that his coffin should be brought down and cleaned out, his glassy eye recovering a passing brightness as he congratulates himself on his wise forethought.

Death is indeed approaching with rapid strides. Only two spoonfuls of the medicine prescribed has the patient swallowed. "Take it away," he says, when he realizes his situation—"take it away, and keep it carefully for the next person who falls ill. It is a pity to waste it on me, for I feel that my time has come, and nothing can do me any more good. Send for the preacher, that I may make my peace with God."

The last dispositions as to house and property have been made in the presence of the pastor or preacher. The house and yard are to belong to the youngest son, as is the general custom among the Saxons. The elder son and the daughter are to be otherwise provided for. The small back-room belongs to the widow, as jointure for the rest of her life ; likewise a certain proportion of grain and fruit is assured to her. The exact spot of the grave is indicated, and two ducats are to be given to the *Herr Vater* if he will undertake to preach a handsome funeral oration.

When it becomes evident that the last death-struggle is approaching, the mattress is withdrawn from under the dying man, for, as every one knows, he will expire more gently if lying on straw.

Scarcely has the breath left his body than all the last clothes he has worn are taken off and given to a gypsy. The corpse is washed and shaved, and dressed in bridal attire—the self-same clothes which forty years previously he had donned on his wedding morning, and which ever since have been lying carefully folded by, and strewed with sprigs of lavender, in the large *Truhe* (bunker), waiting for the day when their turn must come round again.

A snowy sheet spread over a layer of wood-shavings is the resting-place of the body when it is laid in the coffin ; for the head, a little pillow stuffed with dried flowers and aromatic herbs, which in most houses are kept ready prepared for this contingency.

An hour before the funeral, the bell begins to toll the *Seelenpuls* (soul's pulse), as it is called ; but the sexton is careful to pause in the ringing when the clock is about to strike, for "if the hour should strike into the bell," another death will be the consequence.

Standing before the open grave, the mourners give vent to their grief, which, even when true and heart-felt, is often expressed with such quaint realism as to provoke a smile.

"My dearest husband," wails the disconsolate widow, "why hast thou gone away ? I had need of thee to look after the farm, and there was plenty room for thee at our fireside. My God, is it right of thee thus to take my support away ? On whom shall I now lean ?"

*The children near the dead mother :* "Mother, mother, who will care for us now ? Shall we live within strange doors ?"

*A mother bewailing her only son :* "O God, thou hast had no pity. Even the emperor did not take my son to be a soldier. Thou art less merciful than the emperor !"

*Another mother weeping over two dead children exclaims :* "What a misfortune is mine, O God! If I had lost two young foals, at least their hides would have been left to me."

*And the children, standing by the open grave of their father, cry out:* "O father, we shall never forget thee! Take our thanks for all the benefits received during thy lifetime, as well as for the earthly goods thou hast left behind."—*Blackwood's Magazine.*

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## SKETCH OF JULES JAMIN.

M. JULES JAMIN was a man of many talents. He held a high position in the scientific circles of his time, and was equally eminent as a teacher and lecturer; he was also well known in literature; and he achieved respectable success in some of the fine arts. He was able to acquit himself creditably in all this variety in occupations, without sacrificing the excellence of his scientific work; and it is on the last that his fame is founded.

Jules Célestin Jamin was born at Termes in the Ardennes, August 30, 1818, and died in Paris, February 12, 1886. His father had served in the volunteers of the French Revolution, had gained the rank of captain, and had been decorated at the battle of Friedland. The boy was taught in the village school of Vouziers, and afterward in the college at Rheims, where he gained nine prizes in the first year, and received in 1838 the prize of honor in the competition between the colleges of Paris and the departments. In the same year he entered the Superior Normal School, and in 1841 received the first prize in the examinations of physics. From this institution he went to the college at Caen as a teacher of Physics; afterward to the Collége Bourbon (now Lycée Condorcet), and in 1844 to the Collége Louis-le-Grand. In 1847 he received the doctorate of Physical Science for a thesis on the reflection of light by the surface of metals.

The precision, elegance, and solidity of his instruction, say Jamin's foreign biographers, and the value of his scientific work, designated him for some superior professorship. So, in 1852, he was elected Professor of Physics at the Polytechnic School, where he lectured with success till 1881. In 1863 he obtained the chair of Physics in the Faculty of Sciences, where, by the extreme lucidity of his demonstrations, he achieved a great success. When M. Duruy, the Minister of Instruction at the time, founded the public lectures of the Sorbonne, he committed the inauguration of the course to M. Jamin; and the opening was, according to M. Jurien de la Gravière's eulogy in the Academy of Sciences, an event which "aroused the enthusiasm of the multitude." Here Jamin attracted a great number of eager listeners, and displayed, says "Nature," his admirable talent of exposition, as well as his great power of simplifying the most difficult questions, and of indicating by most striking apparatus the methods of solving many intricate problems. The qualities that Jamin displayed in his oral teaching are found in his "Traité Général de Physique," which reproduces his course at the Polytechnic School, and "in which masters as well as pupils find exact descriptions of the actual state of science." This work was published 1858 to 1861, in three volumes.

M. Jamin was elected to the Section of Physics in the Academy of Sciences in 1868. In 1884 he was chosen perpetual secretary in the place of Dumas. His address on the anniversary of the admission of M. Dumas to the Academy was regarded as a rare example of pathetic eloquence; and in 1885 he delivered an address on the occasion of the centenary of M. Arago, which was characterized by its philosophical examination of the labors of that distinguished experimenter, and its thoughtful analysis of his mental powers, as well as by the clearness with which these points were presented.

M. Jamin's labors were carried on in very diverse branches of physics; and he interested himself and became versed in other departments of science and art. While studying for the degree in Physics at the Normal School, he also qualified himself for a degree in Natural Sciences. At Caen he took geological and botanical excursions with his pupils on Sundays. Of his regular studies he was first occupied with optics. His first memoir, already spoken of, on the reflection of light from metallic surfaces, was in this line, and was one of the best studies of the kind. Others were his studies of interferences, and of the measurement of the indices of refraction, of gases, of water under different pressures, and of the vapor of water. He discovered the elliptical polarization of light reflected by vitreous substances near the polarizing angle, and the negative elliptical polarization of fluorine; he published a memoir on colored rings, and invented interference apparatus in which the light reflected on opposed faces of thick transparent rings was utilized. He made discoveries in capillarity. In 1873 he exhibited a foliated magnet which was capable of carrying twenty-two times its own weight, while the greatest carrying power attained by artificial magnets previous to that time had been from four to five times their weight. This result was obtained by substituting, for the thick plate hitherto employed, a sufficient number of very thin plates superposed on each other, and all thoroughly magnetized. In these and other experiments in electrical science M. Jamin was greatly assisted by the research laboratory which M. Duruy had endowed. Among the later fruits of these researches was the perfection of the Jamin electric light, as an improvement upon the Jablochkoff candle. In his description of this lamp, the inventor sums up its qualities by saying: "It lights and relights itself as often as is required; it only requires one circuit for all the neighboring candles; it replaces automatically those which are entirely consumed, by new carbons; it employs no insulating material which might alter the color of the flame; and it requires no preliminary preparation of the carbons, which considerably diminishes the expense." The credit of a simultaneous application of the most important principle of this invention has been claimed for Mr. Robert Sabine. Besides these subjects, M. Jamin applied his researches to the compressibility of liquids; hygrometry, on which he was engaged at the time of his death; specific heats; and the critical points of gases. A paper of his on the "Liquefaction of the Elementary Gases," in which the last subject was brought into bearing, was published in "The Popular Science Monthly" for December, 1884. "By their historical order and succession," says "Nature," "his memoirs indicate the progress of physics in France since the middle of the century to the present day." In literature he was one of the regular contributors to the "Revue des Deux Mondes"; and in the earlier editions of the cyclopædias in which his name is given, these articles are mentioned, along with the "Traité de Physique," as the works by which he was chiefly entitled to distinction. He had taste and skill in music. He was a painter of considerable artistic talent, fond of studying the works of the great masters at the Louvre; and was the executor of "an admirable portrait of Lefebvre," of a picture which is preserved in the church in his native village, and of several paintings which are in the possession of his family.

A neat picture of the versatility of his tastes and of his social qualities is given in the sketch of him in "La Nature" and "Nature": "It was only on his return to Paris from Caen that his great power, elevated ideas, distinguished tastes, and fine intelligence could find a free scope. He remembered always with pleasure how at the age of twenty-five he found himself at once surrounded by an intelligent and enlightened society. He dined in a *pension* with several of his colleagues, who have left names either in science or at the university; with Lefebvre, the eminent professor at the Collége Rollin, with Saisset, Barni, Suchet, La Provostaye; with Faurie, who often brought his friend Sturm. The dinner was followed by long chats, with dissertations on science, philosophy, music, and art, in which Jamin took an active part." He was esteemed by all who knew him, scientific men and others, at home and abroad, for many other qualities as well as for his scientific attainments. "Cruelly touched by family affliction," says his biographer, "he found in the midst of his workers who needed continually his aid and assistance, some relief for his great grief. During some time before his death he seemed to have mastered his sorrows, and to have regained his usual activity." He had replaced Milne-Edwards as Dean of the Faculty of Sciences, and at the time of his death was at the height of his reputation. His death came from heart-disease, after an illness of six months.

# CORRESPONDENCE.

## SAFETY IN THE MANUFACTURE OF HIGH EXPLOSIVES.

*Editor Popular Science Monthly:*

SIR: The article in Number 180, "Popular Science Monthly," from the pen of Professor L. R. F. Griffin, is a somewhat marked instance of the freedom with which some authors are willing to assume the responsibility of becoming instructors of the public upon topics of interest by expression of authoritative opinion based upon observation of a single phenomenon.

That Professor Griffin has taken this position is clearly indicated, not alone by his erroneous statements of the properties of explosives, but by the freedom with which he charges ignorance on the part of the manufacturers and owners of the explosives stored near Chicago, the explosion of part of which he makes the subject of his article.

Inquiry would doubtless have convinced him that the methods he characterizes as "very strange," are those which the experiences of manufacturers, many of whom are skillful, intelligent, and highly educated, who have had added to their own personal experience the experience of generations of predecessors for their guidance, have taught them to be safest of which we have knowledge. That all methods now in use are the best possible, no one would be so bold as to maintain, but the manufacture of so staple articles as gunpowder, and its recent substitute, dynamite, could not be long successfully conducted by ignorant persons while so many highly intelligent men with necessary capital at command are ever ready to avail themselves of the opportunity for commercial success that would be thus offered; and had Professor Griffin sought information on the subject he treats, from those who have life and large capital staked upon the issue of intended skillful control of explosives during manufacture, transportation, and while stored for distribution and sale, he might easily have avoided the publication of errors that are obvious to a greater number of readers than he may have supposed.

Nitro-glycerine is *not* "commonly absorbed in Richmond infusorial earth," when compounded into what is then known as dynamite, and it is doubtful if, of the millions of pounds of dynamite annually made and sold in the United States, there are one thousand pounds made by the use of infusorial earth; and it would practically be impossible to find offered for sale by any manufacturer or dealer any dynamite, in the compounding of which earth or any other inert matter had been used.

Nitro-glycerine is absorbed and made into dynamite *not* "for convenience," but *solely* for *safety*, and in order to make it commercially practicable to transport from place of production to place of consumption in a form that it may be used—nitro-glycerine, which, as such, no transportation company would receive into its custody.

Any manufacturer of gunpowder who built a magazine depending upon "strong walls and a very light roof" to prevent damage in case of accidental explosion, must have intended to store only a very small quantity, or have been fortunate enough never to have seen or known of the disastrous results of any such futile attempt to restrain or direct the force of the explosion of any quantity such as is usually so stored. Where conditions of the absence of exposure to possible fire, or to the acts of ignorant trespassers would permit, a light frame structure would invariably be chosen for storage of gunpowder. The different properties of dynamite demand structures of a material that will resist or diminish the speed of a stray bullet; but the less resistance from the building within which any accidental explosion may occur, the less will be the damage to surrounding property either by atmospheric effect or by flying missiles.

The simplest knowledge of the properties of dynamite would have prevented Professor Griffin from attributing the non-explosion of other magazines in the vicinity to the fact of their being beyond the "limits where displacement would not appear"—referring to the bodily mass of air; and personal presence in the immediate vicinity of a number of accidental explosions of either gunpowder or dynamite would probably induce him to change his opinion that "the mass bodily displaced must be confined within comparatively narrow limits."

To correct the manifest errors in this short article would require many times the space it occupies, and be less gratification to curiosity than the article itself; and it would seem to have been rather curiosity than desire for investigation or instruction that was inspired in the mind of the author by the explosion of which he has written.

Yours truly, A. O. Fay.

Xenia, Ohio, *March* 29, 1887.

### SEX AND BRAIN-WEIGHT.

*Editor Popular Science Monthly:*

Dear Sir: In the April number of "The Popular Science Monthly" there was an article, by Dr. William A. Hammond, entitled "Brain-Forcing in Childhood," of which, in so far as it deals with that subject, I have nothing to say here. But the doctor took occasion to have another fling at women, and to that I wish to reply in a way to give him an opportunity to prove, if he can, that his statements are based upon scientific facts and discoveries. If such discoveries have been made they should be on record, and I am assured by the leading men of his profession that no such records exist.

I propose on my side to prove that his statements on this subject, both in this article and a previously published one, from which I shall also quote, are based upon assumption and prejudice, and can not be sustained by scientific tests either by the doctor or any one else.

Since the published opinions of such a man as Dr. Hammond, and in such a magazine as "The Popular Science Monthly," are likely to have a wide influence upon the welfare and prospects of a large number of women, it is most important that he either prove his case or correct his indictment.

In his article on "Brain-Forcing in Childhood" he devotes two and a half pages to a series of statements regarding the native incapacity of woman, the inferiority of her brain in quality, quantity, and development in what brain anatomists call the nobler proportions; and argues that it is an absurdity to allow girls and women to receive and use the means of development which he admits have *produced* these higher results in man!

Cause and effect, in man, he recognizes as related in the usual manner; while cause and effect in woman appear to have no possible connection.

The higher races of man have a higher brain development than have the lower races. This, he argues, is the direct result of the nature, variety, complexity, and accuracy of their mental training and opportunities. Women's brains in the lower races, he says, are very nearly like those of the men; but in the higher races there is a much greater difference between the brains of the sexes; which, oddly enough, he does not attribute to the fact that they have never been allowed the very training and opportunities which he claims produced the desired change in the males of their race. He holds that it is natural, unalterable difference in the brain-mass itself. Now, if this were the case, would not the difference be quite as marked in the lower races? That the disparity is *not* natural and unalterable, but that it is the result of lack of opportunity and inequality of education and environment, seems to be plainly indicated by his own argument when logically carried to its conclusion. But he argues that, since the *ratio* of difference in the brain of the sexes has not remained the same in spite of the great expansion of opportunity for the one and the restriction of opportunity for the other as they rise in the scale of civilized races, it proves *inability* on the part of the restricted sex. And he then asks for further restriction! This is surely as unscientific as it is illogical.*

All this upon the basis that the doctor can prove that such great anatomical differences do exist in the adult brain. But I hold that it never has been done, and that the doctor can not do it. I prepared a number of questions, for which I regret there is not space here, which were submitted to twenty of the leading brain anatomists, microscopists, and physicians of New York, with the results given below.

Dr. Hammond asserts: "Again, it is only necessary to compare an average male with an average female brain *to perceive at once how numerous and striking are the differences* existing between them." (The italics are mine.) He submits a formidable list of striking differences which include these: "The male brain is larger, its vertical and transverse diameters are greater proportionally, *the shape is quite different*, the convolutions are more intricate, the sulci deeper, the secondary fissures more numerous, the gray matter of the corresponding parts of the brain decidedly thicker." Of this latter point the doctor modestly says that the evidence is not so full as might be desired. But, as if all these were not quite enough to enable the merest novice to distinguish a male from a female brain, he offers these re-enforcements: "It is *quite certain*, as the observations of the writer show, that the *specific gravity of both* the white and gray substance of the brain is greater in man than in woman."†

All this would seem to leave woman without a chance of escape; for if by any accident her brain did not fall short in gray matter, fissures, etc., the specific gravity of the rest of it would enable the doctor to

* "The reason that the brain of the woman is lighter than that of man is, that she has less cerebral activity to exercise in her sphere of duty. *In former times it was relatively larger in the department of Lozère because then the women and the men mutually shared* the burden of their daily labor. The truth is, that the weight of the brain *increases with the use we make of it*."—*Topinard*, p. 120.

† A recent article in "Mendel's Journal," by Morselli—the only recent article which agrees with this theory—while asserting that the specific gravity is less in the female, is compelled to make the sinister admission that "*with old age* and with *insanity* the specific gravity *increases*." If this is the case, I do not know that women need sigh for more specific gravity than they have.

ticket her as accurately as though she were to appear with ear-rings and train in a ball-room. Now, if all this is true, it would surely be the easiest and simplest thing in the world to determine the sex of a subject by an examination of the brain alone. And if these "great and numerous differences" are natural, potential sex conditions, and not the results of difference in education, occupation, mental stimulus, and general environment, they would be as easily distinguished in the brains of infants (of the same age, size, and condition) as in the brains of adults.

The physical sex differences which we all know to be natural, necessary, and inevitable, are as easily distinguishable at birth as in maturity.

Now, I am assured by all of the brain experts and scientists to whom my questions were submitted, that the sex of two infants not only *could not* be "perceived at once," but could not be determined at all by these certainly sufficiently plain and numerous differences in brain size, matter, and condition of which the doctor writes so confidently.

And, further than this, I am assured by the leading brain anatomist in America that no careful scientific observer could risk more than a mere *guess* as to the sex of *adult* brains, even upon the most careful and exhaustive examination.

And even more than this, it is a well-known fact that individual brain differences between persons of the same sex are greater and more numerous than any known to exist between the sexes, and that such a guess would, therefore, be worth very little to a scientific mind.

The difference in weight, for example, between the brains of Cromwell and Gambetta, or Byron and Dante, are absolutely known to be far greater than any known to exist between the sexes, as such, even in spite of the relative lighter body-weight of women. But if Dr. Hammond still believes in these numerous and easily detected sex differences in the brain-mass itself—even including the weight test—I am prepared to offer him an opportunity to prove his case, very greatly advance scientific knowledge, and win for himself fame as an original discoverer in a disputed field. If the doctor will agree to it, we can decide whether he can distinguish sex in brain by a very simple experiment.

I will agree to furnish (by permission of the leading brain anatomists and from their collections) twenty well-preserved brains, marked in cipher, Dr. Hammond to divide the male from the female brains by applying any or all of his numerous and readily perceivable sex tests. If he can not do this, he has certainly lost his case.

In the matter of weight the doctor concedes that the *relative* size and weight of the brain are about the same in the two sexes —slightly in woman's favor—which he says does not count; although, when he finds this same relative difference between two men, he argues that it does count for a great deal. But in the dilemma to which this seemed to reduce him he rushes into a most extraordinary statement. He says: "Numerous observations show, beyond doubt, that the intellectual power does not depend upon the weight of brain *relative to that of the body*, so much as it does upon *absolute brain-weight*." Now, if this were true, an elephant might out-think any of us; and the whale, whose intellectual achievements have never been looked upon as absolutely incendiary (if we except Jonah's friend), would rank the greatest man on record, and have brains enough left to equip a fair-sized female seminary.

The average human male brain weighs from 1,300 to 1,400 grammes, and even a very young whale furnishes 2,312 grammes of "intellect-producing substance," as the doctor felicitously terms it; while the brain of a large whale weighed in 1883 tipped the beam at 6,700 grammes!

Truly, then, if absolute brain-weight, and not relative weight, is to be the test, here was a "mute, inglorious Milton" indeed!

Almost any elephant which disports itself for the amusement of small boys—and the enrichment of Mr. Barnum—is several Cuviers in disguise, or perhaps an entire medical faculty.

So much for the "absolute-weight" statement. There are nineteen other points in the doctor's two articles upon which I have data of a nature as radically opposed to his theories and statements as these; but, since lack of space forbids their introduction here, I can add only one other sample. He says, "A fact which is somewhat astonishing to those not aware of it is, that the head of a boy or girl *does not grow in size after the seventh year*." There is no sort of doubt about that being "somewhat astonishing," but there is a vast deal of doubt about it being a "fact." It does not require a "brain-expert" or anatomist to decide that point. Any hatter knows that it is absolutely incorrect. But lest the whole hatting fraternity be not looked upon as an offset to Dr. Hammond's authority, I have permission to state that one of the leading—and I think I will not exaggerate if I say the foremost—brain anatomist of New York has taken such measurements for many years, and in his own family there is a boy whose head has increased in size steadily up to his eleventh year, and still offers abundant evidence of its future intentions in the same direction. This, he assures me, is not exceptional, but is the usual and normal condition.

Of course, the *ratio* of growth decreases, but the size of the head increases in most persons up to the twentieth year, and usually until about the twenty-fifth.

Sincerely yours,

HELEN H. GARDENER.

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A NATIONAL EXPLORING EXPEDITION.

*Editor Popular Science Monthly:*

DEAR SIR: Whatever the influence has been that has been brought to bear for the past five or six years or more, it certainly has had the effect of moving Congress to appropriate money toward the building of some new war-vessels for our navy, and improving our coast-defenses. No doubt all this was very necessary; but do you know that the signs of the times prompt me to suggest that there are other things that our navy might be doing during these long days of peace, which would reflect far more credit upon us as a nation than if we had the most powerful fleet of war-vessels afloat in the world? Civilized nations are rapidly coming to that chapter in their history wherein it will be plainly shown that those states which will command the greatest measure of respect among us will be the ones which have best advanced the progress of science, art, and learning, and developed the culture that accrues therefrom, and not those who can cast the biggest cannon, and invent engines which will kill the greatest number of human beings in the shortest space of time. Even aside from this, it would almost seem as if our people overlook the fact sometimes that were Congress to appropriate to-day sufficient money to build a navy for this country which would be equal to the navies of such nations as England, France, or Italy, before we would have the opportunity to use it in actual warfare it would be thoroughly outstripped again by the marvelous rapidity of the improvement that is constantly going on in naval architecture. The nations I have mentioned have to be constantly renewing their war-vessels in order to keep up with the advance in such matters, and are continually selling their old patterns to the lesser powers. We have not the competition in the United States to excite any such movement as this, and the men-of-war we build to-day will in all probability be as absolutely powerless to compete with the massive floating steel and iron fortresses of France and England of the future, as if we were to build them as invulnerable as those vessels now are, and attempt to engage with what the same nations will surely possess twenty-five years hence.

One of the great outcries made by the officers of our navy is, that "we are not held in the proper respect on foreign stations," or, in other words, our puny little fishing-smacks do not favorably compare with the ponderous ironclad hulks that represent the naval powers of the world, and tower over them.

Now, I have a notion that the United States would gain an enormous amount of respect in the eyes of foreign nations, if not in the eyes of foreign navies, had she upon any foreign station one of her very best men-of-war and two corvettes, completely remodeled and thoroughly equipped both as regards men, officers, and scientific staff, and the necessary appliances to properly prosecute an exploring expedition around the world. It would seem to me that the commander of such a little fleet, were it anchored in the harbor of Shanghai or Rio Janeiro to-day, would feel a far greater pride in his country than were he in command of a *seventeenth-rate* gunboat, comparatively speaking, and there should steam in, with flying colors, such an infernal engine of destruction as the French man-of-war the Foudroyant or the Dévastation. With all the iron and steel we could rivet on to some of our best war-vessels to-day, they could not be made sufficiently effective to engage, with the slightest hope of success, such vessels as the two I have mentioned. Yet a very moderate expenditure on the part of Congress would splendidly refit them for exploring vessels in every sense of the word, and render them creditable institutions of the nation.

I am convinced that the day will come in the history of the world, whether we hold together as one country or not, when all the exploits of our navy during the war of the rebellion will pale, so far as the credit to humanity is concerned, by what was accomplished by the Wilkes Exploring Expedition; and England will blush when she compares the victories of her Nelson with the results obtained by the Challenger Expedition, and confesses to humanity which was the more important to the progress of the world.

Smile if you will, but I believe the day is coming for us in our race when national disputes will be settled without costing a million lives, and the breaking a million hearts—when war between countries will be as much a thing of the past as the duel is now between individuals; and finally, when the functions of our brain will prevail over the inherited instincts that came down, or perhaps I had better said passed up with us, along with our canine teeth.

Let us repeat, at as early a day as possible, the Wilkes Exploring Expedition, and see whether we do not gain credit, respect, and power by the movement, to say nothing of all that is sure to accrue from it in other particulars. Very respectfully,

R. W. SHUFELDT.

FORT WINGATE, NEW MEXICO, *March* 7, 1887.

# EDITOR'S TABLE.

## *HIGHER EDUCATION OF WOMEN.*

THE interest which this subject is exciting at the present moment is, we take it, a very hopeful sign. The probability would appear to be that, in the clash of opinions, the truth will gradually be beaten out. Every writer brings to the question his or her own contribution of real experience; and, when once we have the facts properly sifted, it will not be such a difficult matter to draw conclusions.

Mrs. Lynn-Linton in England has taken up a position on this subject that places her in antagonism to most of those who have espoused what, for convenience, we may call the women's side of the question. She does not say that women can not take the highest education or make the best use of it, but on the whole she rather discourages, from a practical point of view, the effort to bestow the highest education on any very large number of women. We do not wish to be understood as committing ourselves to all the views she has advanced; but we think she has at least made one forward step by importing certain simple practical considerations into the discussion. She has shown that an advanced education has an appreciable money value to young men in a much larger proportion of cases than it has to young women. Much as we may talk of "education of the mind" and "discipline of the faculties," the education of boys and young men has mainly been dominated by practical ends. We are far from saying that those ends have always been wisely sought; we simply contend that in general they have been recognized. When a young man has been destined for the bar, for the Church, for the profession of medicine, or for some scientific or literary career, there has been a special object in giving him as liberal a preliminary education as possible; and such courses of higher education as have heretofore been devised have had as their main intention the fitting of men for professional careers, and not the mere production of a large number of finely polished intellects destined for no particular function whatever. It may be further said that, in the education of men, the definiteness of the ulterior aim has been to a large extent the circumstance that has rendered the imparting of a sound education possible. The mind can carry what it means to make use of, what it expects to find serviceable, far better than it can what does not point to any special application. The education of men has thus been given a certain concreteness and a certain actuality from the fact of its bearing, or, at the very least, being understood to bear a distinct and definite relation to practical life.

How is it, now, as regards the education of women? It is certainly true that women are taking to-day a much wider share in the work of the world than they did even a generation ago. Many more careers are open to them, and their ability to assume even the most difficult professional duties is no longer doubted. Manifestly, then, a practical necessity has arisen for placing within the reach of women the highest educational advantages. It can hardly, however, be maintained that the somewhat clamorous demand that has been made of late years on behalf of women for such advantages has been mainly inspired by the desire to enable women to hold their own in various professional walks. The object has rather been to produce a generation of gifted women without reference to any special practical use to be made of their high accomplishments. "Culture" for culture's sake has been the idea, rather than culture for the sake of more efficient *work*. Now, we are well aware that to some it will sound like a great heresy, but we must frankly confess that we do not believe in culture for culture's sake, nor in art for art's sake, nor in science for science's sake, nor even in truth for truth's sake. We believe that culture and art and science and truth all find their value in the *human life* which they tend to beautify and improve. When culture is given merely for culture's sake, it lacks definiteness of aim, and never seems to know what boundaries to observe. We fancy—though at this moment we are not prepared to speak positively on the point—that we see a result of the "unchartered freedom" of female education in the more ambitious programmes of female seminaries as compared with those devoted to the teaching of young men. Men know that they must concentrate their energies if they are to succeed in the special objects they have set before them. Women, not having (in general) such special objects, think the whole circle of knowledge none too vast for their grasp. We read in a recent article by a lady upon a well-known college for ladies that, "in passing from class-room to laboratory and lecture-room, while observing the work done by professors and students, one can not fail to be astonished at its breadth and depth and wide scope, at its immense quantity and superb quality. Pages would be required to do it full justice." Is there any college for men in this country to which such a description could be applied without seeming somewhat overstrained? We certainly do not remember to have seen anything so glowing of either Harvard, Yale, Johns Hopkins, or Columbia.

Supposing, now, we ask for a moment, What is "higher education" for any given individual? we should be inclined to answer—with that bent toward practical views which we have already avowed—that it is not so much education in the minutiæ of any branch or branches of knowledge, as education dominated by a relatively high purpose and expressly directed to the perfecting of the individual life with reference to its normal sphere of activity. Now, individual life is not perfected, not improved, by any education that ministers to vanity or ambition. That the college education of young men often has that effect we are quite sure; that the college education of young women has it still oftener we are disposed to believe. Anything that has such an effect forfeits, in our opinion, its title to be regarded as "higher education," since it really is the education and stimulation of lower impulses and instincts. Apart from this consideration, however, true intelligence is not always promoted by the imparting of a great variety of knowledge, or even by the special prosecution of particular lines of study. Whether the mind becomes truly intelligent depends upon whether it is enabled to apply to every-day life the lessons of the school-room, and to see all knowledge in its practical bearings. Many minds, male and female, are, we are convinced, simply educated away from true intelligence by the costly efforts that are made to give them the highest educational advantages. As between men and women we draw at present no line whatever in respect to intellectual qualifications. That the distinction of sex extends to mind as well as to bodily organization we think highly probable; but precisely how the distinction operates in the mental region can not be dogmatically affirmed; and the best thing to do under the circumstances is to let the distinction, if there is one, establish itself in practice. Let the same educational facilities and privileges be available for women as for men; and in the course of time we shall perhaps see better than we do now what modifications need to be introduced into the education of women. The principle of equality once firmly laid down, it remains to be said that, from the point of view of the intellectual future of the female sex, too much importance probably is being attached to what is called "higher education." It is safe to say that such intellectual advantages as men now enjoy are but in a minor degree dependent on colleges and universities. We constantly see men arriving at high scientific and literary eminence, with little or no aid from scholastic institutions; and what is possible for men is possible for women. The last thing we should wish to do would be to disparage systematic training; but still it is an indubitable fact that many have contrived to accomplish great things without it. Upon the whole, it is an encouraging thought that "higher education" is not confined to seminaries of learning. It can be imparted largely in the home-circle; it can be obtained by independent study and reflection. Let the seminaries flourish, but let it be understood that common sense and right feeling, and worthy aims in the household and in society, constitute in themselves the conditions, and even in some degree the elements, of higher education. We should like to see this whole question reduced to its true proportions and brought into direct relation with the realities of life. We believe that women (like men) have at the present moment within their reach far more extensive means of culture than they care to avail themselves of; and that what is really wanted for the diffusion of higher education in the best sense is not so much the multiplication of institutions of learning, as the communication of an impulse to individuals of a nature to lead them to lay hold of the means of intellectual improvement that abound on every side. Could this be accomplished, the general intelligence of society would advance with rapid strides; while the multiplication of institutions of learning, and dependence on them for intellectual results, will only give us a select class of educated, sometimes over-educated, persons, and will leave society at large but slightly modified by the culture that really ought to mark this advanced stage of human progress.

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### THE GREEK QUESTION AGAIN.

Since the article on the "Present Status of the Greek Question" appeared in the May number of "The Popular Science Monthly," we have been informed by a graduate of the University of Cambridge, England, that it is now possible to obtain the degree of B. A. from that ancient institution of learning without any knowledge of Greek whatever. This marks, of course, a new era in the history of this question in England.

It may be worth while to glance for a moment at the amount of Greek required for the B. A. at the various British universities where it is still insisted upon as a required subject of examination. We have not the requisitions of Oxford before us, but we are assured that they do not exceed those of the University of Edinburgh and other Scottish universities for the M. A. According to the "Edinburgh University Calendar" for 1883–'84, the Greek set for examination for the degree of M. A. comprised the following: "Odyssey," book vi; Sophocles's "Electra;" Thucydides, book vi, and Plato's "Protagoras." Now, when we consider that these authors and the particular works or portions of their works to be set are thus announced a year beforehand, it will be seen how small an amount of work in Greek is really required for this degree. It does not amount to more than is required for entrance to the classical course of any good American college. A Cambridge graduate has asserted that it was quite feasible for a man, in the days when Greek was required at Cambridge, actually to commit to memory the portions of Greek set, and to go through the examination successfully after two or three months' hard grinding, without obtaining the shadow of an idea of Greek grammar even, to say nothing of Greek literature or history! Of course, no sane man would maintain that in the case of men who actually did this any such advantage in the way of culture and mental discipline could accrue, as is claimed for the study of Greek in general.

It is very curious to compare the views of the adherents of compulsory Greek in Germany, England, and America. They all agree in maintaining that the course of required Greek in their respective countries accomplished wonders in the way of education. When we compare, however, what is actually required for graduation in a German gymnasium, for example, in the A. B. course at Cambridge, and in an A. B. course in any American college of good standing, we find that the course in Germany requires fully six years of earnest study; in America at least four or four and a half; and in England not over two or three at the very most. The German apologist for Greek would maintain, however, that the small amount required in America or England is not worth a rush (as indeed some of them have said in answer to a proposition to diminish the amount of Greek required to something like the American or English standard, and that they had better cut it out altogether rather than treat it in such a "stepmotherly" way); the American claims that the small amount given in England is of little or no value, and insists that the present requirements in America shall not be cut down.

Outsiders can hardly be blamed for coming to the conclusion that the Germans are right, and that we should either require enough to make it worth the while, or else cut it out altogether from the list of required studies. As it is not at all likely that the amount required will ever be increased, the only thing to do is to get rid of that little which according to the most competent judges is worth nothing at all.

We would not be misunderstood, or have opinions ascribed to us which we do not hold. We do not desire to attack the study of Greek or the policy of offering the most ample facilities for its pursuit. On the contrary, we consider that from no branch of study can one whose tastes lie in that direction derive more benefit in the years before he takes up special lines of work than from Greek. But we can not disregard the fact that such pupils are usually only one or two among a large class who are looking forward to some higher course of instruction, who succeed in accomplishing more than merely to drag through the prescribed course. We believe that many students, who might be capable of showing marked talents in other directions have been deterred from advancing to higher courses of instruction by the fact that Greek lay in the way. In schools dominated by the classical spirit, every sort of talent is measured by its ability to make grade in the classics. All who can not come up to this standard are made to feel that they are considered inferior students. They are "specials," or "partials," or "generals," or something else, which implies that they are not so good as the regular classical students. We can not but think that this fact has lain at the bottom of the failure of many a one in the past, who under a different system would have been quickened to a new intellectual life and raised into a higher sphere of usefulness.

The notion that liberal views of life, wide intellectual sympathies, a broad humanity—in a word, that all those qualities that should distinguish a gentleman and a scholar from his opposite—are the exclusive products of one line of studies, may be, we think, properly enough characterized as a fetich; and it is a fetich which has done and is doing much harm in the educational world. We believe it is losing its hold upon the minds of men very rapidly, and that we have great reason to congratulate ourselves upon this fact. Its final destruction need not, and we do not think it will, lead to the disappearance of Greek from our courses of liberal study, but it will deprive it of that peculiar position of predominance which it has held in Western education for the last three hundred years—a predominance which, however beneficial at some stages of our modern era, is now the source of far more injury than benefit.

*ANNOUNCEMENT.*

The editor takes pleasure in announcing the commencement, in the July number of "The Popular Science Monthly," of a series of articles, by David A. Wells, on the economic disturbances commonly spoken of as "A Depression of Trade and Industry," which have prevailed to a greater or less extent throughout the whole civilized world since the years 1872–'73; and, in the opinion of not a few economists and investigators of repute, are yet very far from having come to an end. The subject, considered either historically, or in view of its bearing on industrial progress, the accumulation and distribution of wealth, and the relations of capital and labor in the future, is one of the highest interest, and has already engaged the attention of several national commissions on both sides of the Atlantic. It is almost unnecessary to state that the author brings to its discussion—which necessarily involves the phenomena of the so-called "over-production," the discontent of labor, the depression of prices, bimetalism, and the increasing tendency among nations to impose artificial restrictions on trade and commerce—the results of very thorough study, as well as world-wide reputation for determining and popularly presenting economic facts and conclusions. Mr. Wells is known as a trained observer, who looks at things with judicial fairness, and has formed the habit of arriving at his opinions independently of all prejudice, and of presenting them with candor and precision. It is, therefore, reasonable to anticipate that his conclusions will command, as they deserve, very general attention.



# LITERARY NOTICES.

## INTERNATIONAL EDUCATION SERIES.

The Rise and Early Constitution of Universities, with a Survey of Mediæval Education. By S. S. Laurie, LL. D. New York: D. Appleton & Co. Pp. 31 + 293. Price, $1.50.

The many teachers, parents, and others who are forced to decide between conflicting policies in higher education will be greatly helped toward an intelligent decision by a study of the methods which prevailed in the early universities. It is the aim of the third volume of the "International Education Series" to present a general survey of these methods. The author begins with a sketch of the schools whose character was determined by the union of Roman and Hellenic culture in the time of Augustus, and traces their decline after the Christianizing of the empire, and the rise of Christian schools in their stead. The influence of Christianity at first was to discourage the earlier culture, as tending to foster paganism, or, at best, as being a mere dissipation. All teaching in the Christian schools was with a view to pious uses, and the curriculum was generally restricted to arithmetic, reading the psalter, and music. These schools had reached quite a promising condition in the sixth century, but retrograded in the seventh and eighth, so that when Charlemagne became Emperor of the West the education of Europe was in a barbarous state. This monarch made the improvement and extension of the episcopal and monastery schools an important part of his policy. To his court at Aix he invited such men of learning as could be found. The emperor was fond of music, and promoted the reform of church singing, introducing the Gregorian Chants, and it is said, also the organ. But his reform in education, and that of Alfred in England a half-century later, were temporary in their effects. During the three centuries after the death of Charlemagne, learning languished in Europe, but among the Arabs at this period it was flourishing. About 1100 there arose *studia generalia*, or what we should now designate as professional schools, called forth, as Professor Laurie believes, by the growth of learning demanding specialization, by the rise of a lay feeling in connection with the work of the physician, the lawyer, and even the theologian, and by the actual specializing of the three leading studies at different centers of instruction. These schools were open to all the world, free from monastic rule, and self-governing. The name *university* came later. In 1224, Frederick II combined the three faculties with a school of arts at Naples, and incorporated the University of Naples, with definite authority and privileges. The University of Bologna first became noted as a school of civil law; later instruction in canon law, arts, medicine, and theology, came to be given. The University of Paris had a similar gradual development. The term *universitas* had at first no reference to the scope of the curriculum, but meant simply a community. In form of government, the literary communities copied the free trade-guilds. The rights to practice and to teach medicine were the first degrees. The degree of *Baccalaureus Artium* originally marked the end of what was regarded as a preparatory course, fitting the student to commence his study in arts for the master's or teacher's degree. Professor Laurie sets the time of the beginning of university life at Oxford, at about 1140, and at Cambridge about 1200, and he thinks their university organization arose about 1230, after the large migration of students came to them from Paris. The University of Prague, founded in 1348, by Charles IV, was the starting-point of the great German system of universities. It followed the plan of Paris, where Charles had been a student. In his closing chapter Professor Laurie gives an interesting account of the university studies and the conditions of graduation in the twelfth and thirteenth centuries, from which the reader may learn how many current academic forms are survivals of mediæval practices.

Elements of Physiological Psychology. By George T. Ladd, Professor of Philosophy in Yale University. New York: Charles Scribner's Sons, 1887. Pp. 696. Price, $4.50.

We consider this the best book that has ever been published in America upon that particular branch of psychology of which it principally treats. It deals chiefly with the nervous mechanism and correlations with the mind, embracing under the latter head questions of the localization of cerebral functions, the quality of sensations, their quantity, the various presentations of sense, the time-relations of mental phenomena, feelings and motions, the physical basis of the higher faculties, and certain statical relations of the body and mental phenomena. Thus far and within these limits the book is excellent. The latest results of the study of mind from the physical point of view are thoroughly exhibited. The fruits of German study are especially well presented, and the recent work done by the Johns Hopkins University scholars in establishing the existence of the temperature sense, we are glad to see, meets, with the author's recognition. Without taking the space to particularize merits, and without searching for particular and minor defects, we are justified, upon the whole, in commending highly this work as far as the close of Part Second.

The third part, entitled "The Nature of Mind," ought to have been entirely omitted. It is not only superfluous, but painfully unsatisfactory. No sufficient foundation is laid for what is said, and the treatment itself is extremely inadequate. Until the other branches of psychology beyond the physiological are considered, even hypotheses or surmises respecting the ultimate nature of mind are out of place. The author in his introduction attempts to justify the metaphysical discussions and theses with which the work closes on the ground that psychology inevitably leads up to philosophical questions, and must furnish the basis upon which they are to be answered. Undoubtedly so; but that does not warrant a writer who makes a book covering only a portion of psychology in giving us his metaphysics as if established by psychology generally. His work presents only a part of the data, and until he has gone over the whole ground he has no business with ultimate questions. The topic, "The Nature of Mind," is indeed interesting, but it is greatly to be regretted that Professer Ladd could not restrain himself from discussing it until the opportunity was afforded in some clearly appropriate connection.

A Treatise on Surveying, comprising the Theory and the Practice. By William M. Gillespie, LL. D. Revised and enlarged by Cady Staley, Ph. D. New York: D. Appleton & Co. Pp. 549 and 127. Price, $3.50.

Professor Gillespie's standard treatise on "Land-Surveying," published in 1855, was prepared with a view of producing "a very plain introduction to the subject, easy to be mastered by the young scholar or the practical man of little previous acquirement, the only prerequisites being arithmetic and a little geometry; and at the same time to make the instruction of such a character as to lay a foundation broad enough and deep enough for the most complete superstructure which the professional student may subsequently wish to raise upon it." A second work, on "Leveling and Higher Surveying," was left unfinished at the author's death, but was completed by the editor of the present volume, and published in 1870. These two works have now been revised and combined by Dr. Staley. The general divisions of the resulting treatise are land-surveying, leveling, topography, triangular surveying, hydrographical surveying, and mining surveying. Somewhat more than half of the body of the volume is occupied with the first of these divisions, comprising minute descriptions of instruments, directions for making measurements, keeping field-notes, platting surveys, and practical instruction in laying out, parting off, and dividing up land, including the methods used in surveying the public lands of the United States. In the section on leveling, spirit-leveling receives most attention, and brief accounts are given of the methods of trigonometric and barometric leveling. Under topography, modes of topographical representation are abundantly illustrated, and the use of the plane table is described.

An Appendix is devoted to a synopsis of plane trigonometry, and another takes up certain theorems relating to transversals, harmonic division, and the complete quadrilateral. Following these are an analytical table of contents, traverse-tables, tables of chords, logarithms, logarithmic sines, etc., and natural sines, etc., a stadia table, and a table of refraction in declination. The volume contains abundant illustrations of instruments and operations, and an isogonic chart of the United States for 1885-'86.

Social Studies. By R. Heber Newton, New York: G. P. Putnam's Sons. Pp. 380. Price, $1.

This is a collection of essays on social questions, some of which appeared originally as articles in periodicals, while others were prepared for special occasions; thus, three of them were read before the Church Congress; one before the United States Senate Committee on Education and Labor; one at the annual banquet of the Chamber of Commerce; and one before the Free Religious Association. The titles are: "A Bird's-Eye View of the Labor Question"; "The Story of Co-operative Production and Co-operative Credit in the United States"; "Is the State just to the Workingman?" "Old-Time Guilds and Modern Commercial Associations"; "The Prevention of Intemperance"; "Moral Education in the Public Schools"; "The Free Kindergarten in Church Work"; "The Religious Aspect of Socialism"; and "Communism."

The Westminster Review. Vol. 128, No. 1. April, 1887. London. Trübner & Co. New York: The International News Company.

This Review, now in its sixty-fourth year, with the current number makes a new departure. Henceforth it will be issued monthly, and various changes will be made in the direction of suffusing the work with fresh vigor and adapting it to altered conditions of the reading public. Among other things it promises to "give special attention to the literature of science," and that "the exposition and discussion of scientific subjects (which, in comparison with the whole of the other departments of intellectual activity, have now attained commanding pre-eminence and supreme importance) will in future constitute a distinctive feature of the work." We understand that the intention is to allow about three eighths of the space of each monthly issue to American contributions; of the latter there are two in the number before us, both excellent articles: one, by Hon. Oscar S. Straus, United States Minister to Turkey, upon the "Development of Religious Liberty in America"; the other, by Thomas G. Shearman, Esq., entitled "The Protectionist Revival in Great Britain." These articles have an American copyright. The next number, we are informed, will contain an article by Mrs. Clara Lanza, of this city, upon "Fiction as National Literature," and another by Horace E. Deming, Esq., also of New York, upon "The Machine in American Politics."

Tables for the Determination of Common Minerals. By W. O. Crosby. Boston: J. Allen Crosby. Pp. 74.

The reasons which have led Professor Crosby to publish these tables are that the best tables which have preceded them are overloaded with descriptions of minerals seldom met with, and give determinations based largely on chemical properties, which are not so conveniently ascertainable as the morphologic and physical properties. Professor Crosby's tables, which are an outgrowth of his experience as an instructor at the Massachusetts Institute of Technology, aim to determine about two hundred species—all that the student is likely to have occasion to identify—by their more obvious physical and structural features, adding chemical tests to be used when the identification is not otherwise perfectly satisfactory. Only those tests have been selected requiring the minimum of apparatus, reagents, and previous chemical training. The properties of minerals, and the chemical and blow-pipe tests referred to in the tables, are explained in an introduction. In the tables, minerals are divided first into two classes, those with metallic and those with non-metallic luster, and then by the color in the former class and the streak in the latter, and further by the hardness; they are subdivided into forty-one groups. A concise physical description of each species is given, by which it may be distinguished from the others of the same group, and the last column of the tables is devoted to chemical tests. An index of species is appended.

The Argentine General Catalogue. Mean Positions of Southern Stars determined at the National Observatory, Benjamin A. Gould, Director. Cordoba. 1886.

This volume puts the public in possession of the main results of Dr. Gould's great labors in Cordoba. The catalogue contains 32,448 stars, and there are many hundreds more in appended lists of clusters, the number of observations exceeding 145,000. The work includes nearly all the stars in the southern heavens, down to the $8\frac{1}{2}$ magnitude, the exceptions chiefly lying north of 23° of south declination, a region already covered by other catalogues. Of the surpassing accuracy of the work, and the minute care with which every part of it has been executed, it would be impertinent for us to speak. To the layman, the contemplation of such a monument of genius, bending itself to incalculable assiduity, is truly a moral lesson.

A Systematic Hand-Book of Volumetric Analysis. Adapted to the Requirements of Pure Chemical Research, Pathological Chemistry, Pharmacy, Metallurgy, Manufacturing Chemistry, Photography, etc., and for the Valuation of Substances used in Commerce, Agriculture, and the Arts. By Francis Sutton, F. C. S., F. I. C. Fifth edition. Philadelphia: P. Blakiston, Son & Co. Pp. 491. Price, $4.50.

When discoveries of chemical reactions and methods are being published so voluminously as at present, frequent revisions are necessary to keep a manual of analysis abreast of the times. In preparing this edition of his hand-book, Mr. Sutton has completely revised the work, and has added new methods. He has excluded some of the matter of previous editions as being of little value, among which is the systematic analysis of soils and manures by volumetric methods, also that of indigo, for which no satisfactory process is known. The opening section of the book is devoted to a description of apparatus and instruments. The second section is on analysis by saturation, and comprises alkalimetry and acidimetry, including in each division the examination of a number of commercial products. This section includes descriptions of the new indicators derived from the azo-colors, which have been introduced recently by R. T. Thompson. The third section deals with analysis by oxidation or reduction, and the fourth with analysis by precipitation. The foregoing principles are then applied to the estimation of the important elements and radicals, which are taken up in alphabetical order. A chapter is devoted to the analysis of urine, potable waters, sewage, etc., and another to gas analysis. In the latter field there has been marked improvement in technical processes since the last edition of this work was issued. The book is well supplied with illustrations showing forms of apparatus, and methods of arranging it for special operations.

Mineral Resources of the United States. 1885. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 576.

The present volume is the third of a series designed to present the principal statistics concerning the mineral productions of the United States, together with such descriptive matter as will throw light upon the condition of the industries which those products materially affect, or will aid in utilizing material which has no value at present. The first volume covered 1882 and the first half of 1883; the second volume continued the record till the end of 1884. These volumes were noticed in the "Monthly" when they appeared. The present volume includes the calendar year 1885. The material for the accounts has been obtained by canvass for precise returns where that was practicable; otherwise, from estimates of authorities as checked by actual returns from all available sources. Much of it appears in the form of special articles by persons who are experts, or have given particular attention to the subject. The principle is observed of not repeating (except in the tables) information given the previous year; hence it happens that, where no change has been made in the conditions, attending any product, that title may temporarily disappear from the record. Prominence is given in the presentation to coal, coke, petroleum, natural gas, and the economical metals under some of which headings several articles of special value appear. Thus, Mr. Joseph D. Weeks treats of the manufacture of coke, of natural gas, manganese, and glass materials; Mr. S. H. Stowell, of petroleum; J. M. Swank, General Manager of the American Iron and Steel Association, gives a review of twenty-one years of progress in manufacture; C. Kirchhoff, Jr., contributes articles on the copper, lead, and zinc industries of the United States; Mr. David T. Day, on chromium, zirconium, phosphatic rock fertilizers, and iodine; Mr. N. S. Sproule, on structural materials; Mr. George F. Kunz, on precious stones; William C. Day, on sulphur and feldspar; Herbert J. Davis, on pyrites; Marcus Benjamin, on mineral paints; G. F. Perrenoud, on talc; and A. C. Peale, on mineral waters.

A Treatise on Algebra. By Professors Oliver, Wait, and Jones, of Cornell University Ithaca, N. Y.: Dudley F. Finch. Pp. 412.

This work is a text-book for college classes, being planned especially for the classes conducted by its authors. It is, therefore, not a book for beginners, but for students who have already studied the elements of algebra and geometry. In writing it the authors have had two rules for their guidance. One was, to assume no previous knowledge of algebra, but, starting from primary definitions and axioms, to develop the elementary principles in logical order; the other was to define clearly every word and symbol used in a technical sense, to state formally every general principle, and, if not an axiom, to prove it rigorously, to state formally every general problem, and to give a rule for its solution with reasons, examples, and checks. The book contains much matter that is not found in the common college algebras—more, in fact, than can be used with ordinary classes—yet its wide range is expected to make it valuable as a reference-book for teachers, and as a guide for students who wish to pursue the study beyond the usual limits. The authors have pursued a course which they believe accords with the tendencies of modern algebraic work, in utilizing graphic representation, the elements of infinitesimal analysis, and the calculus of operations, for the purpose of attaining a natural and philosophical presentation of the subject. Symbolic language has been largely employed; in some cases larger meanings have been given to old words, and new words and symbols have been introduced. Another edition is to contain chapters on the theory of equations, integer analysis, symbolic methods, determinants and groups, probabilities and insurance, and an index will be added.

The Scientific Writings of Joseph Henry. Washington: Published by the Smithsonian Institution. Two vols. Pp. 523, 559.

These volumes comprise the first collection that has been made of Professor Henry's scientific writings. The original papers, having been given to the world from time to time through a period of more than fifty years, and published in widely remote places, are now generally rare, and in many cases nearly inaccessible. Their value, even at this time, as we glance over them in these handsome volumes, might well strike with surprise persons who, recognizing how much advance has been made in research during the last sixty years, would naturally imagine that they were superseded by what has been discovered since they were written. But most of them were in the lead of the science of the time of their production, and some of them, even on subjects now of the most lively investigation, read as if they might have been written to-day. It was a becoming act in the Regents of the Smithsonian Institution to present these writings in the noble shape in which they appear; and we can join with them in the feeling which they express that it seemed to them "that justice to the name and memory of their distinguished Secretary who made the Institution what it is, no less than a due regard to the history of physical science in this country, and the interests of its present votaries, require that these writings should now be collected and made available." The act is all the more graceful, because, as the regents also observe, "it is noteworthy, and indeed is characteristic of their author, that he sedulously abstained from publishing any of his researches of the later period or reproducing any of the earlier ones—very important though he knew them to be—through the inviting channel of the 'Smithsonian Contributions,' or 'Miscellaneous Collections,' or in any way at the expense of the Smithsonian fund." The writings are naturally grouped under two periods: the first, comprising the record of the author's researches from 1824 to 1846, during his professorial career at Albany and Princeton; and the second that of his scientific work from 1847 to 1878, during his directorship of the Smithsonian Institution at Washington. The arrangement of the papers is chronological, except that the series recording the author's observations on the phenomena of sound are, for the sake of equalizing the size of the volumes, removed from their proper position in the second volume to the end of the first volume; and the second volume is made to begin with a continuous presentation of the series of meteorological essays. The publication is made under the direction and supervision of Dr. Asa Gray, the Hon. W. L. Wilson, and Professor S. F. Baird, committee.

Transactions of the Modern Language Association of America. 1884–'85. Vol. I. Baltimore: Published by the Association. Pp. 250: Modern Language Notes. A. Marshall Elliott, Managing Editor. Eight numbers a year. Baltimore. Pp. 48. Price, 15 cents a number.

We have already noticed the formation of the Modern Language Association, and its objects, which may be briefly expressed as to encourage and exalt the study of the modern languages, and to secure to them their equal place of consideration with the ancient languages and other branches of college study. The present volume of its "Transactions," with its eighteen papers on various aspects of the subject, shows how well it is working to its purpose. Two of the papers are mainly literary. A half-dozen of them may be grammatical. Professor Alcée Fortier gives an interesting account of "The French Language in Louisiana and the Negro-French Dialect." The other papers refer more or less directly to practical questions of instruction in modern languages and English literature. Professor W. T. Hewett considers the aims and methods of college instruction in modern languages; Professor N. G. Brandt inquires how far our teaching and text-books should have a scientific basis; and Professor J. M. Hart, how the college course in English literature may be improved. Professor F. V. N. Painter outlines "A Modern Classical Course"; Professor T. W. Hunt defines the place of English in the college curriculum; aud Dr. Francis B. Gunmere asks, "What Place has Old English Philology in our Elmentary School?" "German Classics as a Means of Education" (Goethe) is discussed by Dr. Julius Goebel; "The Requirements in English for Admission to College," by Professor G. R. McElroy; "The Use of English in teaching Foreign Languages" by Professor H. C. G. von Jagemann; and "The Real-Gymnasium Question," by Professor A. Marshall Elliott.

The "Modern Language Notes" began its second year with the January number, 1887, considerably more than twice as large as was the first number, yet with price unchanged, and with subscriptions and advertising lists that have more than covered expenses since the sixth issue. The matter is of a piece with that of the "Transactions," with the addition of book reviews, brief paragraphs, and such current news as has a connection with modern language studies. It is intended henceforth to give, with running comments, the titles of leading articles appearing in foreign journals devoted to the modern languages, and to keep abreast with the best production in this branch of linguistic science.

The American Naturalist. Vol. XXI. No. 1. January, 1887. Philadelphia: J. B. Lippincott Company. Pp. 110. Price, $4 a year.

With the beginning of the current year, this periodical passed into the hands of the J. B. Lippincott Company, of Philadelphia. Professor Cope continues as leading editor, while Professor Packard, his associate, retires, and is succeeded by J. S. Kingsley. With these gentlemen co-operate seven experts in their special branches of science as "Department Editors" in Geography, Mineralogy, Botany, Embryology, Physiology, Anthropology, and Microscopy. The publishers announce that the history of the "Naturalist" during the twenty years of its existence has been one of gradual development, that its subscription list now much exceeds that of any previous period, and its prosperity is fully assured. It is creditable to our people that this should be so, for appreciation of a journal of this character, and of one that maintains so high a standard as that of the "Naturalist," is a sign of no ordinary degree of cultivation, and of a desire to learn science by working in it. The "Naturalist" was a pioneer in its field, and it occupies a sphere which no other journal so fully and so peculiarly fills. In last year's volumes original articles appeared from one hundred American naturalists, and a like list of contributors is in prospective for the present year. In the hands of so extensive and successful a house as that of its new proprietors, its opportunities for usefulness are certain to be greatly increased.

Latin Word-Building. By Charles O. Gates. New York: D. Appleton & Co. Pp. 160. Price, 98 cents.

This manual is intended to aid in removing the difficulty which Latin students feel in translating at sight, growing out of ignorance of the exact meaning of the root-words. Experience has taught that the vocabulary is more readily mastered and exact and definite meanings of words are more easily acquired and retained by making familiar the significance of the roots and associating with it the meanings of the modifications, with affixes and suffixes, endings, etc., by which they are affected, and so reaching the significance of derivative words by a kind of general rule, than by looking out all the words singly in the dictionary. The manual aims to assist in this process. The method is, first, to learn the exact meaning of the root-word; then to acquire the definite meanings of the more common words derived from the root-word; and then to utilize the information thus gained by translating sentences illustrating these words from the author next to be read in regular course. The first part of the volume comprises an etymological vocabulary, in which the meanings of the root-words, their modifications, and groups of their derivatives are given, with space left on the page for the insertion by the pupil of such new matter as his readings may suggest. The second part contains sentences from Cæsar and Cicero, to which what is learned from the vocabulary may be applied. In the appendixes are given tables of the meanings of prepositions in composition, and of the common terminations of words; exercises on forms; and rules for translation.

Telegraphing to and from Railway-Trains: Duplex Telephony. By Dr. A. M. Rosebrugh. Pp. 11.

These are two papers which were read before the Canadian Institute, discussing the question of the priority of invention of the two processes named. Both inventions are claimed by the author for Canada.

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## PUBLICATIONS RECEIVED.

"Art and Letters," an Illustrated Bimonthly Magazine. April, 1887. New Orleans, La.: New Orleans Publishing Company. Pp. 40. 50 cents a number, $3 a year.

Alcott, A. N. The Problem of Fellowship in Religion. A Study of the Present Unitarian Situation. Pp. 38.

Currier, Andrew F., M. D. Some Considerations concerning Cancer of the Uterus. New York: Pp. 17.

United States Bureau of Statistics. Quarterly Report to December 31, 1886. Washington: Government Printing-Office. Pp. 80.

Kellogg, E. L., & Co., New York. The Best One Hundred Books. Pp. 68. 20 cents. Books for Young People. Pp. 20.

Harrower, Henry D. Captain Glazier and his Lake. New York: Ivison, Blakeman & Co. Pp. 58.

Chaillé, Sanford E., Tulane University, Louisiana. Abuse of Alcoholics by the Healthy. Pp. 36.

Marsh, Professor O. C. American Jurassic Mammals. Pp. 20, with Four Plates.

Meigs, Joe V. The Meigs Elevated Railway System. Boston. Pp. 182.

Snow, Marshall S. The City Government of St. Louis. Baltimore: N. Murray. Pp. 40. 25 cents.

Adams, Herbert B. American Historical Association. Report of the Proceedings, Third Annual Meeting. 1886. New York: G. P. Putnam's Sons. Pp. 104. $1.

Shufeldt, R. W. The Veterinary Service of the United States Army. Pp. 6. The Camera and Field Ornithology. Pp. 2.

Harrison, J. B. The Latest Studies on Indian Reservations. Philadelphia: Indian Rights Association. Pp. 233. Free to members.

"The American Missionary." Monthly. New York: American Missionary Association. Pp. 32. 50 cents a year.

Yandell, David W., M. D. Doctorate Address at the Semi-Centennial Anniversary of the University of Louisville Medical Department. Pp. 26.

Stowell, T. B., Ph. D. Natural History in Secondary Schools. Pp. 5.

Dubois, Professor A. J. Science and the Spiritual. Bridgeport, Conn.: Bridgeport Scientific Society. Pp. 32.

Agricultural College of Michigan. Feeding Steers of Different Breeds. Pp. 8.

White, Andrew D. A History of the Doctrine of Comets. New York: G. P. Putnam's Sons. Pp. 43. 25 cents.

Bulletin of the Scientific Association of Peoria, Ill. 1887. Pp. 92.

Stevenson, John J., New York city. The Faults of Southwest Virginia. Pp. 8.

Griswold, W. M., Washington, D. C. The Continuous Index to Periodicals. Bimonthly. March and April, 1887. Sheet. 50 cents a year.

Allen, Charles A., New Orleans, and others. What is Unitarianism? Pp. 18.

Western Unitarian Association, Chicago. Unitarian Christianity. Pp. 16.

State Reservation at Niagara. Third Annual Report of the Commissioners. Pp. 87.

Crothers, T. D., Hartford, Conn. Cause and Cure of Inebriety. Pp. 11.

Adams, Herbert B. The College of William and Mary. Washington: Government Printing-Office. Pp. 89.

Rush, H. G., New Danville, Pa. The True Doctrine of Orbits. Pp. 133.

Pickering, Edward C. Report of the Photographic Study of Stellar Spectra at Harvard College Observatory. Cambridge, Mass.: John Wilson & Son. Pp. 10, with Plate.

Brewster, Mary Shaw. First Book of Chemistry. New York: D. Appleton & Co. Pp. 144. 77 cents.

Mendenhall, T. C. A Century of Electricity. Boston and New York: Houghton, Mifflin & Co. Pp. 229. $1.25.

Heron-Allen, Edward, and Horsely, Rosamund Brunel. Practical Cheirosophy. New York: G. P. Putnam's Sons. Pp. 125.

Ebers, Georg. The Bride of the Nile. New York: William S. Gottsberger. 2 vols. Pp. 386 and 378.

Rolfe, William J., editor, Tennyson's Enoch Arden, and other Poems. Boston: Ticknor & Co. Pp. 166. 75 cents.

Terry, Samuel Hough. Controlling Sex in Generation. New York: Fowler & Wells Company. Pp. 209.

Peck, William G. Elementary Treatise on Determinants. New York: A. S. Barnes & Co. Pp. 471.

Beal, W. J. Agricultural College of Michigan. Grasses of North America. Published by the author. Pp. 457. $2.50.

"Annual Statistician." 1887. L. P. McCarthy, Editor and Proprietor. San Francisco. Pp. 648.

Crane, Thomas Frederick. Le Romantisme Française. A Selection from the Writers of the French Romantic School. 1824–'48. New York: G. P. Putnam's Sons.

Nicholson, Henry Alleyne. Text-Book of Zoology for Junior Students. Fourth edition, revised and enlarged. New York: D. Appleton & Co. Pp. 888.

Hunt, T. Sterry. A New Basis for Chemistry. Boston: Samuel E. Cassino. Pp. 165.

Andrews, C. C. Brazil. Its Condition and Prospects. New York: D. Appleton & Co. Pp. 352.

Adams, Herbert C. Public Debts. New York: D. Appleton & Co. Pp. 407. $2.50.

Miller, L. W. The Essentials of Perspective. New York: Charles Scribner's Sons. Pp. 107. $1.50.

Cook, George H. Geological Survey of New Jersey. Annual Report for 1886. Trenton, N. J. Pp. 254.

Bancroft, Hubert Howe. History of Central America. Vol. I, 1501–1530. San Francisco: The History Company. Pp. 704. $5.

# POPULAR MISCELLANY.

**Elective Studies in American Colleges.**—Most of the leading colleges of the country, according to President Barnard, are admitting the elective principle more or less freely into their courses of study. In 1876 Yale College extended its very limited optional list from a minute fraction of the studies of the junior year to about one fourth of those of both junior and senior years. It was enlarged again last year, so that now, out of sixteen hours weekly, seven only are given to prescribed studies in the junior year, and three hours only in the senior. At Princeton one third of the time is given to prescribed studies in the junior year, and three hours in the senior. At Bowdoin about four fifths of the studies are prescribed during both junior and senior years. At the University of Pennsylvania and at Williams College the published announcements indicate that the time of the two later years of the course is about equally divided between prescribed and optional studies. At Rutgers it is allowed to elect one study during the junior and senior years. At Union one third of the time is given to elective studies during the senior year only; but this institution offers also elective courses, a classical and scientific course running through the entire four years. At Brown electives are offered as early as the sophomore year, when they occupy about one fifth of the time. In the same institution, in the junior year, they extend to one third, in the senior to about one half. At Amherst electives cover about one half the time during the second and third of the three terms of the sophomore year, and during the whole of the two later years. In the University of Michigan all the studies are elective after the close of the freshman year; and at Harvard University there are no prescribed studies at all.

**Medicines and Digestion.**—Dr. Robert G. Eccles lately called the attention of the Brooklyn Pathological Society to the importance of regarding the effect of medicines to be administered upon digestion. "We never stop," he says, "to question the wisdom of pouring into the stomachs of the sick, in the most promiscuous manner, drugs that inhibit or check the production of life- and health-giving peptone. In all chronic diseases, the paramount consideration is that of the patient's nutrition. Where we can not destroy the pathogenic micro-organisms outright, the patient's only hope in the struggle for life lies in the strength of his cells, and their power to triumph over their foes. The most important consideration at those times is digestion. To interfere with it, or check it, is in many cases criminal. When our remedies are incompatible with the gastric juice, the time of taking is likely to be of far more importance than the medicine itself. To weaken patients by the production of artificial mal-nutrition, gives their diseases the advantage over them, when a little more knowledge would have enabled us to aid the vital forces instead of handicapping them." The author described the properties of various remedies in this light, and gave accounts of a large number of experiments which he had made on the subject.

**Coal-Tar Colors and Medicines.**—Sir Henry Roscoe lately addressed the Royal Institute on "Recent Progress in the Coal-Tar Industry." He said that the hydrocarbons, the essential elements, or skeletons of all organic compounds, are classified as the paraffinoid—the bases of the fats—and the benzenoid hydrocarbons, which give rise to the essences or aromatic bodies, to which all the coal-tar colors, finer perfumes, and anti-pyretic medicines belong. The natural petroleum-oils consist almost entirely of paraffines, and are therefore commercially inapplicable for the production of colors. Coal may by suitable treatment be made to yield oils of a valuable character; and these products are now extensively obtained from the coal-tar which is a residue of the gas-making process, and of coking, when the conditions of temperature are properly managed. Even to enumerate the different chemical compounds which have been prepared during the last thirty years would be a serious task. To illustrate the amount of coloring-power concealed in coal, Sir Henry Roscoe presents tables showing that one pound of the mineral affords magenta enough to color 500 yards of flannel; aurine sufficient for 120 yards of flannel 27 inches wide; vermilline scarlet for 2,560 yards of flannel or alizarin for 255 yards of Turkey-red cloth. We are at present acquainted, among the derivatives from coal-tar, with about sixteen distinct yellow colors, about twelve oranges, more than thirty reds, about fifteen blues, seven greens, and nine violets; and a number of browns and blacks, besides mixtures of the several chemical compounds, giving rise to an almost infinite number of shades and tones of color. These colors are capable of a rough arrangement according as they are originally derived from one or other of the hydrocarbons contained in the coal-tar. In the class called azo-colors, an azo or nitrogen group replaces the hydrogen in phenols and amido-compounds. They are chiefly bright scarlets, oranges, reds, and yellows, with a few blues and violets. Next in importance to the color industry comes the still more novel discovery of the synthetical production of antipyretic medicine. The initiative in the production of these compounds was given in the discovery by Professor Dewar, in 1881, that quinoline, their basis, is an aromatic compound; from it he obtained aniline. Kairine, the first of the antipyretics in the order of discovery, is manufactured from quinoline. It effects a remarkable lowering of the temperature of the body, which, however, is of much shorter duration than that effected by quinine; but, with the exception of its burning taste, it exerts no such evil effects as are often observed after the administration of large doses of quinine. Antipyrine, the second of these febrifuges, was discovered in 1883. It is made from aniline and aceto-acetic ether. As a febrifuge, it is superior in many respects to kairine and even to quinine. It equals kairine in the certainty of its action, while in its duration it resembles quinine. It is almost tasteless and odorless, is easily soluble in cold water, and takes the form of a white crystalline powder. Its use in medicine is accompanied by no drawback. A third artificial febrifuge is thalline, which is said to be used as an antidote for yellow fever. None of these substances are anti-periodics; and consequently they can not supplant quinine in cases of ague and intermittent fevers. Another group of coal-tar products comprises the artificial aromatic essences. Among these are cumarine, the principle of "new-mown hay"; vanilline, of vanilla, with its derivative vanillen, which is used in preparing "essence of heliotrope"; mirbane, a soap-perfume, and the artificial oil of bitter almonds. The most remarkable of all the coal-tar products is probably saccharine, a substance which surpasses sugar in sweetness. It is not a sugar, for it contains sulphur and nitrogen, nor does it act as a nutriment, but it is non-poisonous, and passes out of the body unchanged.

**A Lesson in Practical Anthropology.**—Sir C. W. Wilson, in a paper read in the British Association, on "The Wild Tribes of the Soudan," after describing the tribes and their clans, with their divisions and alliances, remarked that it was interesting to observe how thoroughly General Gordon had understood the situation in that region, and at once pointed out the remedy. When he left England, his instructions had been to proceed direct to Suakin, open up communication with the supreme sheik of the Hadendowas who had taken no part in the rebellion, and isolate and crush Osman Digma by raising against him the surrounding tribes, whose sheiks he knew personally. There can be little question that if this policy had been carried out early in 1884, before Sinkat fell and Baker Pasha had been defeated, it would have been successful. But, unfortunately, General Gordon's plans were changed and he proceeded up the Nile. Mr. Hyde Clarke congratulated the section on having had such a paper submitted to them, and said that Sir Charles Wilson had given them a useful exemplification of the value of anthropological studies. They had seen how incidents in the war in the Soudan had turned rather on the knowledge of the men than of the physical features of the country.

**Photography of the Stars.**—Professor Edward S. Holden has given, in the "Overland Monthly," a popular account of the methods and an estimate of the expectations of stellar photography. The photographic telescope requires special construction and arrangement of the lenses, which differentiate it from ordinary telescopes. If it is set fixed, the image of the star passing across the sensitive plate will leave a "trail," which is the visible representative of the direction of the star's diurnal motion. If arranged with a driving-clock, so as to follow the star in its motion, it will give a bright point, the photographic image. If we wish to make a picture of the sky, we must register the stars by such points as these. But the trails have various advantages, one of which it that they can not be mistaken for dust or for pin-holes on the plate itself; to avoid the liability to which, the dot-pictures are always repeated. The position of dots in latitude and longitude can be very accurately measured; the latitude of the star can be even better determined from its trail, but its longitude must be determined by special devices. The proper length of exposure for a star of the first magnitude is not more than $\frac{5}{1000}$ of a second. For a star just visible to the naked eye, half a second is enough; for stars of the tenth magnitude, twenty seconds; of the twelfth, two minutes; of the thirteenth, five minutes; of the fourteenth, thirteen minutes; and for the faintest stars visible, an hour and twenty-three minutes.

**Fire-Proof Mixtures.**—The processes employed to make cloths and woods uninflammable ought to satisfy the following conditions: 1. The preservative substance or mixture should be cheap and easily used. 2. It should not change either the cloths or their colors. 3. It should not be poisonous or corrosive. 4. Cloths or woods impregnated with it should remain uninflammable after having been exposed for a month to a temperature of 100° and over. "La Nature" gives a few of the preparations which seem best to satisfy the different conditions required. A mixture applicable to all light fabrics consists of pure sulphate of ammonia, 8 kilogrammes; pure carbonate of ammonia, 2·5 kilogrammes; boric acid, 3 kilogrammes; pure borax, 2 kilogrammes; starch, 2 kilogrammes, or dextrine, or gelatine; water, 100 kilogrammes. Cloths should be dipped in the solution at a temperature of about 84°, till they have soaked it well up, then partly dried in the air, and afterward dried enough to be ironed like starched clothes. The quantity of starch, dextrine, or gelatine, may be varied according to the degree of stiffness it is desired to give the goods. This mixture is good for ball-dresses. A quart of it will serve for the preparation of about sixteen yards of goods. A mixture applicable to canvas that is already painted and to mounted scenery, to woodwork, furniture, curtains, bedclothes, cradles, doors, and windows, and which can be mixed with dyes, consists of sal-ammoniac, 15 kilogrammes; boric acid, 5 kilogrammes; glue, 50 kilogrammes; gelatine, 1·5 kilogramme; water, 100 kilogrammes, with lime enough to give the proper consistency. It should be employed at a temperature of from 122° to 140°. The pieces may be dipped into it or painted with it. In case of decorations already painted it is enough to whitewash the backs of the canvases, and the frames on which they are hung, with the preparation. A kilogramme of it will paint five square metres of surfaces. A mixture applicable to heavier canvases, cordage, straw-work, wood, and carpentery, consists of sal-ammoniac, 15 kilogrammes; boric acid, 6 kilogrammes; borax, 5 kilogrammes; water, 100 kilogrammes. It is used at a temperature of 212°. The immersion should continue fifteen or twenty minutes, after which the piece should be aired and then dried. Another mixture is applicable to plain or printed papers. It consists of sulphate of ammonia, 8 kilogrammes; boric acid, 3 kilogrammes; borax, 2 kilogrammes; and water, 100 kilogrammes. It is used at a temperature of 122°. To resolve the problem completely—that is to reduce the action of heat on combustible articles to a simple calcination and render them uninflammable, and consequently incapable of starting or supporting a fire—the compositions should protect the fibers of the cloth or wood from contact with the air during the whole continuance of the heat; and the combustible gases disengaged by the heat should be mixed with so strong a portion of other, incombustible gases as to be no longer inflammable. Therefore, the cloth or the wood should be painted with a very fusible substance which, on the first impression of heat, will cover the surface of the fibers, adhere to them, and prevent the contact of the air. Salts that crumble under the action of heat, or of long-continued dryness, those that are hard to melt, efflorescing and hygrometric substances, are, therefore, not the most suitable for these applications. Borax and boric acid, which are included in the four receipts here given, are very fusible, and are not changed by heat, but only by an excess of moisture in the air, and well fulfill the first condition. Hydrochlorate, carbonate, and sulphate of ammonia readily give off incombustible gases, which have also the positive quality of extinguishing combustion, and thus admirably fulfill the other condition. Hence the compositions recommended possess all the desired qualities. They have also responded satisfactorily to varied tests of experiment.

**A New African Region.**—The Rev. David Asante, a native missionary of the Basle Gold Coast mission, Africa, recently visited during a journey of exploration the hill-country of Booso, where he says the temperature is cool, rains are frequent, and rivulets numerous. The country is thinly peopled by a population subject to goitre and extremely dirty, whose children and bachelors wear no clothing. Wives, being harder to get—by the process of wooing and winning their consent—than in most African countries are treated well. The fetich-worship is less subtile than on the coast, but the poison-ordeal is frequently resorted to, and accounts for the small population. When a person dies, a whole village sometimes submits to take an infusion of a poisonous bark. Quarrels are settled by resorting to the same dangerous arbiter, thefts are discovered by it, babies who cry much are made to swallow the infusion to prevent their growing up wicked, and parents who lose several children in succession take it in order that the cause of their affliction may be discovered.

**Petroleum Products as Fuel.**—The residues of the distillation of petroleum have been employed in the Caucasus for several years as a combustible, and have appreciated from having no value in 1874 till they command a price six times higher than crude naphtha, which is now employed as a cheaper fuel. Naphtha has been considered dangerous on account of its explosive qualities, but it has been found that they disappear when the liquid has been exposed to the air for a few days till it has lost its volatile constituents, which compose about fifteen per cent of its substance. Crude naphtha, right from the springs, is burned in the locomotive-furnaces of the Balachanskoi railroad, and there are no accidents. Naphtha is the fuel that develops the greatest quantity of heat, and it also possesses the great advantage of not containing sulphur or other injurious substances. Ninety per cent of the theoretic calorific power can be realized from it, while not more than sixty per cent can be got from solid combustibles. In 1859, doubts were expressed in Russia as to whether petroleum could be used as a combustible; now it is employed exclusively on all the ships in the Caspian Sea, and only half as much of it is required as used to be consumed of coal. The maximum force to be obtained from petroleum is equivalent to two and a half times what coal will furnish; and experiments on the railroad from Baku to Balachan show that a given weight of naphtha will take the place of eight and a half times the weight of wood, although the theoretically calculated difference in calorific power is only as three to one. Petroleum is very conveniently introduced into the furnaces of locomotives with the injectors that are used; the combustion is very easily regulated, and the furnaces last well in the absence of sulphur, while no smoke, sparks, or ashes, are emitted.

**Make Room for City Children.**—Dr. James B. Russell, health-officer of Glasgow, while he admits that the moral delinquencies of parents, and particularly drunkenness, are important factors to the death-rate of children in cities, insists that too much influence should not be attributed to them. The child of sober, industrious parents, in a city of good sanitary conditions, still lacks room for his complete well-being. The element of space comprehends all the physical conditions of health so completely that the name density is recognized by vital statisticians as the best standard of comparative measurement. Then, as the child grows up, comes the natural desire for play and exercise, which is essential for health and growth. Pent up as city children are, their play becomes in great part mischief. The prevailing characteristics of children's play correspond with the manners, habits, and occupations of the adult population; thus, city children may very often be seen playing at being drunk, or at policemen and thieves, and at fighting. Nothing can be more pitiful than this compulsory perversion of a natural instinct into unwholesome ways. Among the best methods of recruiting city children, the author recommends the system of holiday "colonies," which is in vogue in several European countries. Selected, poor, weakly children, between the ages of seven and fourteen, are sent in colonies of from ten to forty each, under teachers, and the month constituting the school holiday is spent at farm-houses or school-houses in the open country. The improvement in health from these outings has been proved not to be temporary. Provisions for a similar purpose in some of the cities of the United States are commended. The laying out of cities needs to be modified with reference to the requirements of children. Wherever the element of space is involved in any proposed legislation, let the people support that which will give them the most space about their dwellings. They would save increased taxation in doctors' bills and burial expenses. They should remember that the most useful open spaces are those which are close to their houses. Distant parks are not substitutes for the occasional simple play-ground in the heart of the city. Both together form a provision for the young children as well as for the adults.

**The Great Inland Depression of Brazil.**—It is interesting, says Mr. J. W. Wells, in a paper on "The Physical Geography of Brazil," to note the great depression that extends through the center of the South American Continent, practically similar to what exists in the North American. A canoe can be navigated from the Rio Orinoco to the Rio Negro, thence to the Amazons, then up the Rios Madeira, Mamoré, Guaporé, aud Alegré, where it will not be more than five or six hundred feet above the sea. It can then be hauled across a low, grassy flat, as is often done, to the Rio Agoapehy, and then descend by the Rio Jauru and Rio Paraguay to Buenos Ayres. The distance from the Amazons to the Plate by this route is about twenty-five hundred miles, of which sixteen hundred and fifty miles have already been traversed by steamers, leaving eight hundred and fifty miles to be navigated. But it must not be inferred that the whole of this route offers an almost uninterrupted course of navigable rivers; on the contrary, the remaining eight hundred and fifty miles that have not been explored by steamers, not only contain insurmountable obstacles to the passage of even the lightest-draught steamer, but in many places to even the ascent of a canoe. Yet this route will most probably be, in the more or less remote future, the main line of internal communication. By far the greater part of the lands of this natural way are as undeveloped as the Congo of Africa. A connection also exists between the Rio San Francisco and the Rio Tocantins. A canoe can leave the former river and go up the Rios Grande, Preto, and Sapão. The source of the last river is in a beautiful lake in a valley surrounded by fortress-looking table-topped hills; the margins of the lake are bordered by groves of grand Burity palms; on the west the lake drains out into a quick-flowing, considerable stream, the Rio Diego, joins a Rio Preto, and thence onward by the Rio do Sonno to the Tocantins. This journey could be made without once taking the canoe out of the water, except to descend with safety a few rough stretches on the western outlet of the lake.

**The Gapes in Chickens.**—Dr. H. D. Walker has contributed to the "Bulletin" of the Buffalo Society of Natural Sciences the result of the special investigations which he has made to determine the origin of the gape-worm (*Syngamus trachealis*) of fowls. He believes it to be a parasite of the earthworm (*Lumbricus terrestris*). Taking the opportunity of a prevalence of the gapes among the chickens, in 1883, and acting under the advice of Dr. Leidy, he sought for the *Syngamus* in the embryonic or larval condition, in some intermediate part. This might, he thought, be the earth-worm, the sow-bug (*Oniscus asellus*), or the garden-slug, all of which were found around the infected coops; while the coops that suffered most were near a bare spot of ground which was full of earth-worms. Parasites were found in the earth-worms and in the slugs. The three animals were fed separately to different chicks. No significant effect followed the feeding with slugs or sow-bugs, but the chicks fed with earth-worms developed symptoms of gapes. Experiments were made in artificial culture, and are described in the author's paper. For prevention of gapes, Dr. Walker recommends keeping the chickens away from the ground by putting them on floors, and destroying the earth-worm and its parasite by some preparation fatal to both, such as common salt; asafœtida and garlic, which have been relied upon to cure or prevent gapes, had no effect upon the *Syngamus*.

**Dr. Bickerton's Experiments in Color-Blindness.**—T. H. Bickerton, of the Royal Ophthalmic Hospital, Moorfields, has recorded the results of his personal examinations of 5,087 subjects, during five years, for color-blindness. Holmgren's tests were used. Of 3,087 men and boys tested, 179 failed at the first test (a very pale, pure green), either by omitting green, or by putting in some other color. Of these, 74 passed successfully the remaining tests, and were considered to have but a very slight chromatic defect, which might be disregarded. Rejecting these, there were 105 cases of color-blindness, or 3·40 per cent of the whole number. Of 1,841 women and girls examined, 3 only, or 0·162 per cent, were to a greater or less extent affected, and of these one so slightly affected that it was cast out, leaving 2 pronounced cases, or 0·108 per cent. Sixty-four male lunatics afforded 1 complete and 1 incomplete case, while 95 female lunatics were all correct. The social status of these and other persons examined varied from the lowest to the highest, and the ages ranged from five years upward. A large majority of them were under twenty-one. Besides those included under the head of very slightly color-blind, there were others whose color-perception was feeble. Among the lower social grades, as represented by the children in orphanages and reformatories, a considerable number made mistakes in the examinations, and these errors were made not only by those of dullish intellects, but also by those who, according to their mistresses, were sharp girls. Cases of this kind were retested after some months' tuition in colors, and in most instances, where ignorance was suspected, the second trial proved the correctness of that conclusion; but there were others who, although they fulfilled the test, did it with the utmost difficulty. Of the 105 cases of color-blindness, Dr. Bickerton further remarks: "Not one so affected was aware of the defect, and a number of them do not believe it to this day. It may seem curious that people who can not distinguish as different colors red, green, and brown, and in some few cases blue and yellow also, do not themselves discover their peculiarity in their vision for colors. Yet, strange as it may be, so it is, and you will find it exceptional for a color-blind to realize in the first instance the defect himself."

**Effect of Climatic Changes on Species.**—Any theory of the distribution of species, to be acceptable, must take account of the great gaps which appear in the extension of many kinds. Mr. Edward Forbes and many other modern botanists believe that the question is one of changes of climate; or that the climatic variations of the past are reflected in the fauna and flora of the present. Their views are partially confirmed by the observations which Professor A. Blytt, of the University of Christiania, has made of the climatological relations and the distribution of plants in Norway. Nearly all the climatological lines there run more or less in the shape of the coast, so that the climates are ranged in bands, the changes being observed as one goes from the interior toward the sea, or *vice versa*. In keeping with the same are the variations of the flora. The plants may be divided into groups, wherein the species belonging to the same group have a somewhat similar extension, while each of the groups is confined to special climatological conditions, and is found only in those parts where the conditions corresponding with its nature prevail. The flora is generally monotonous; but there are certain places dependent partly, perhaps, on the character of the soil, but as much upon exposure to the sun and protection from the changeableness of the coast climate, where a rich vegetation may be found. The flora is destitute of peculiarly characteristic species, because it has come to the country by immigration after the Glacial period, from other countries which were free from ice at that time. This immigration must have taken place during repeated changes of climate. "After several thousands of years with a severer climate that favored the immigration and extension of northern and eastern species, other thousands of years followed with a milder climate. During this period fresh immigrants came from the south and southwest, compelling the older flora to retreat. In this manner the climate must have changed several times since the Glacial age, and the distribution of the plants must have changed in accordance therewith. The periods of variation are reflected in the present flora, and it is the former which have led to the great gaps in the extension of coast as well as inland plants. The sunny screes, the slate districts, and the moist coast tracts, are asylums where the different floras have found refuge. In the intermediate parts they have been dislodged by the new-comers. But certain species, being indifferent to the variations, extended constantly, at the expense of others, and this is the reason of the Norwegian flora being so monotonous."

**Artificial Digestion.**—O. Petersen, of St. Petersburg, has made experiments to ascertain the influence of certain medicines on digestion. The problem he set himself to determine was the time required to digest from 20 to 40 grammes of dried albumen by the aid of 450 centigrammes of a specially prepared artificial gastric fluid. Alcohol in the proportion of five per cent did not hinder digestion, but the process was retarded as the percentage rose, and stopped at ten per cent of alcohol. Antipyrin, in light doses, was without influence, but in larger quantities slightly retarded the action. One or two grammes of bromide or iodide of potassium hindered the process a little. The organic preparations of iron scarcely affected the time required for the digestion, while reduc d iron and the inorganic salts slowed the action, as did also magnesium and sodium sulphates, even in moderate doses. A gramme-dose of chloral hydrate had no slowing effect, though a marked retardation occurred with a dose of a gramme and a half. Chloride of sodium did not retard digestion, even when employed in large doses.

# NOTES.

A SERIES of charts, showing the surface temperatures of the Atlantic coast waters, from Maine to Florida, is under preparation by the United States Fish Commission, assisted by the Lighthouse Board and Signal Service. Observations, covering five years in time, have thus far been made at twenty-four lighthouse-stations. The temperatures at the several stations are shown for each year by ten-day means, and in such a manner as to give the isothermal relations of the stations.

IT is said, on the authority of "an American railway engineer," that low temperatures do not decrease the strength of rails, as is commonly supposed, although it is true that accidents are more likely to occur from broken rails in cold weather. This is because, when the ground is frozen hard, it loses its elasticity. Nevertheless, something must yield when the train runs over the road; it is the ground that yields in unfrozen weather; but during a freeze the ground will not yield, and the rail, as being the weakest part of the structure, has to suffer the consequences.

MR. BLANFORD, in his report on the "Administration of the Meteorological Department of India" for 1885–'86, describes the steps which have been taken in the peninsula to discover to what extent forests influence the rainfall. A few observatories have been established in the Ajmere forests, and the results so far have been to show slightly but appreciably higher rainfall in the forests than without. It is admitted that more careful inquiry must be made before any definite conclusions can be drawn. Mr. Blanford points out that M. Woeikoff, in a paper on the subject with special reference to India, essentially supports the view, which he himself regards as probable.

THE Paris Academy of Medicine has been discussing the bad results of mental strain on young persons. A particularly hard bearing of the process was shown upon French girls, twelve thousand of whom are competing for diplomas entitling them to two thousand appointments in government schools.

PROFESSOR SARGENT, Director of the Arnold Arboretum, of Harvard College, estimates that five foreign trees are planted in New England to one native. Yet, of all foreign trees introduced into America, the willow alone, he thinks, has qualities not possessed in a greater degree by some native. The European oak, and the Scotch, Austrian, and Corsican pines all die at about the time when they should be at their prime, and the Norway spruce, at a corresponding age, is decrepit and unsightly.

Oyster-culture is carried on actively and with yearly increasing returns at Arcachon and Auray in France. Fifteen thousand of the 37,500 acres of the bay of Arcachon are now covered with oyster-beds, which yield 300,000,000 oysters a year. The oyster-beds at Auray, on the coast of Brittany, are less important than those of Arcachon, but they furnished 70,000,000 oysters in 1885.

The Hon. Carroll D. Wright has reported upon convict-labor that the system of hand-labor under public account is the best. The facts show that the contract system is objectionable though it is the most profitable one, and sustain the complaints that are made against it. Mr. Wright believes that none of the disadvantages arising under the contract system or the piece-price modification of it could be urged against the plan he recommends, and the adoption of it would reduce the effects of convict-labor on rates of wages to a minimum.

According to a report from the Internal Revenue Office, there are in the United States 37 oleomargarine-factories, and 266 wholesale and 3,537 retail dealers in that product who paid special taxes in November, December, January, and February last. During the same months, 12,645,740 pounds of oleomargarine were manufactured, and 152,797 pounds were exported.

The jubilee of Professor Otto Struve was recently celebrated at the Pulkova Observatory, and was honored by the attendance of many delegates from learned societies and scientific institutions.

It is related, as among the incidents of the Charleston earthquake, that a young girl who had lost her power of speech from infancy, through severe illness, found it suddenly restored in the terror of the shock. Her first use of the recovered faculty was to scream for fear; but, finding she was able to scream, it took but a step to discover that she could also frame words.

If the stories that are told are true, the negroes at Charleston showed during the earthquake how the power of old habits would cling to them, notwithstanding the great changes that have taken place in their condition. After having been trained for twenty years in the cultivation of self-reliance and the recognition of their parity with the whites, it is said that, when the earthquake came, next to their dependence on the Deity was conspicuous the trust they put in the white people; and, whenever they caught sight of a white face in the darkness and confusion, "they would turn to it as to that of an angel."

The tenth annual meeting of the American Society of Microscopists will be held in Pittsburg, Pennsylvania, beginning August 30th.

President Harrington, of the Ottawa Field Naturalists' Club, has suggested a test of what we really know about objects with which we imagine ourselves well acquainted. "Sit down with paper and pen," he says, "and try how much you can write about some species with which you are familiar, and you will probably be surprised to find how little there is regarding it of which you are entirely certain. Unless your memory for details is much better than mine, I fear your history will be far from exhaustive. It is easy to believe that you are fully acquainted with a certain form, that you know where and when it appears, and its manner of life and reproduction, but when you attempt to record these, doubts begin to flit through your mind, and your knowledge seems less assured."

We noticed some months ago that Captain Willard Glazier claimed that he had discovered in 1881 the true source of the Mississippi River in a lake, hitherto unexplored, a short distance above Itasca Lake, to which he gave his own name. The validity of the discovery was disputed; the Minnesota Historical Society took it up for examination; and its report by the Hon. James H. Baker demonstrates that Captain Glazier's claim is of the most fraudulent character. The lake, the true name of which is Elk Lake, is not new, but was known to Schoolcraft and Nicollet, was marked on their maps, and has been marked upon every map of respectable pretensions since 1832. Mr. Henry D. Harrower has also established the same facts in a pamphlet published by Ivison, Blakeman & Co., in which he shows by parallel columns that Captain Glazier stole a considerable part of his narrative bodily from Schoolcraft. The reports afford a convincing exposure of an attempted imposture, which was as silly as it was impudent.

It has been observed in Ottawa, Canada, that the introduction of the electric light in street illumination has facilitated the collection of entomological specimens, particularly of rare species, as insects of all kinds are attracted to the lamps in large numbers.

## OBITUARY NOTES.

Dr. Grothe, of the Polytechnical School at Delft, died on the 10th of February, in the eighty-first year of his age.

M. Thollon, astronomer at the observatory in Nice, died April 8th, after a long illness, at the age of fifty years. His name was associated with many important discoveries in spectroscopy, the most notable of which, perhaps, was that of the means of distinguishing between telluric and solar rays.

ISAAC LEA.

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# THE ECONOMIC DISTURBANCES SINCE 1873.

By Hon. DAVID A. WELLS, LL. D.

## I.

THE existence of a most curious and, in many respects, unprecedented disturbance and depression of trade, commerce, and industry, which, first manifesting itself in a marked degree in 1873, has prevailed with fluctuations of intensity up to the present date of writing (1887), is an economic and social phenomenon that has been everywhere recognized. Its most noteworthy peculiarity has been its universality; affecting nations that have been involved in war as well as those which have maintained peace; those which have a stable currency, based on gold, and those which have an unstable currency, based on promises which have not been kept; those which live under a system of free exchange of commodities, and those whose exchanges are more or less restricted. It has been grievous in old communities like England and Germany, and equally so in Australia, South Africa, and California, which represent the new; it has been a calamity exceeding heavy to be borne, alike by the inhabitants of sterile Newfoundland and Labrador, and of the sunny, fruitful sugar-islands of the West Indies; and it has not enriched those at the centers of the world's exchanges, whose gains are ordinarily the greatest when business is most fluctuating and uncertain.*

* The poverty in Australia, in 1885, was reported to be more extreme than at any former period in the history of the colonies; multitudes at Adelaide, South Australia, surrounding the Government House and clamoring for food—the causes of distress assigned being failure of the harvest, drought, and general commercial depression.

"The close of the year 1884 brought with it little, if any, improvement, in the material condition of South Africa. Commercial disasters may not have been so frequent as during the previous year, but this may be explained by the fact that trade has reached so low a level that very little room existed for further failures. No new enterprises have

One of the leading economists and financiers of France, M. Leroy Beaulieu, claims that the suffering has been greatest in his country, humiliated in war, shorn of her territory, and paying the maximum of taxation; but not a few stand ready to contest that claim in behalf of the United States, rejoicing in the maintenance of her national strength and dominion, and richer than ever in national resources.

Commenting upon the phenomena of the industrial depression subsequent to the early months of 1882, the Director of the United States National Bureau of Labor, in his report for 1886, considers the nations involved, in respect to their relations to each other and to severity of experience, to stand in the following order: Great Britain, the United States, Germany, France, Belgium. The investigations of the director also indicated a conclusion (of the greatest importance in the consideration of causes); namely, that the maximum of economic disturbance has been experienced in those countries in which the employment of machinery, the efficiency of labor, the cost and the standard of living, and the extent of popular education are the greatest; and the minimum in countries, like Austria, Italy, China, Mexico, South America, etc., where the opposite conditions prevail. These conclusions, which are concurred in by nearly all other investigators, apply, however, more especially to the years prior to 1883, as since then "depression" has manifested itself with marked intensity in such countries as Russia, Japan, Zanzibar, Uruguay, and Roumania.

The business of retail distribution generally—owing, probably, to the extreme cheapness of commodities—does not, moreover, appear to have been less profitable than usual during the so-called period of depression; in contradistinction to the business of production, which has been generally unprofitable.

It is also universally admitted that the years immediately precedent to 1873—i. e., from 1869 to 1872—constituted a period of most extraordinary and almost universal inflation of prices, credits, and business; which, in turn, has been attributed to a variety or sequence of influences; such as excessive speculation; excessive and injudicious construction of railroads in the United States, Central Europe, and Russia (1867–'73); the opening of the Suez Canal (1869); the Franco-German War (1870–'71); and the payment of the enormous war indemnity of fifty-five hundred million francs (eleven hundred million dollars) which Germany exacted from France (1871–'73). The con-

been set on foot, and the suspension of many of the public works has tended to further reduce the commercial prosperity of the country. Consumption has been upon the lowest possible scale, retrenchment universal, and want of employment, and even of food, among the laboring-classes, a grave public difficulty."—*United States Consul* SILER, *Report to State Department, 1885.*

January, 1885. "The price of mackerel in 1884 (Boston) was lower than at any time since 1849; and, in the case of codfish, the lowest since 1838.

"The price obtainable for sugar at Barbadoes entails a loss to the producer in excess of one pound per ton"—*Barbadoes Agricultural Reporter, February, 1887.*

temporary comments of two English journals, of recognized authority, on the course of events in 1872, constitute also an important contribution to our information on this subject. Under date of March, 1873, the London "Economist," in its review of the commercial history of the preceding year, says :

> Of all events of the year (1872) the profound economic changes generated by the rise of prices and wages in this country, in Central and Western Europe, and in the United States, have been the most full of moment.

And the "London Engineer," under date of February, 1873, thus further comments on the situation :

> The progress of events during 1872 will not soon be forgotten by engineers. The position assumed by the working-classes, and the unprecedented demand for iron and machinery, combined to raise the cost of all the principal materials of construction to a point absolutely without parallel, if we bear in mind that the advance of prices was not localized, but universal, and that the duration of the rise was not limited to a few months or weeks, but, having extended already over a period of some months, shows little sign at this moment of any sensible abatement. *In 1872 scarcely a single step in advance was made in the science or practice of mechanical engineering. No one had time to invent, or improve, or try new things.* The workingman is setting spurs to his employers with no gentle touch, and already we find that every master with capital at stake is considering how best he can dispense with the men who give him so much trouble. Of course, the general answer always assumes the same shape—use a tool whenever it is possible instead of a man.

The period of economic disturbance which commenced in 1873 appears to have first manifested itself almost simultaneously in Germany and the United States in the latter half of that year. In the former country the great and successful results of the war with France had stimulated every department of thought and action among its people into intense activity. The war indemnity, which had been exacted of France, had been used in part to pay off the debt obligations of the Government, and ready capital became so abundant that banking institutions of note almost begged for the opportunity to place loans, at rates as low as one per cent, with manufacturers, for the purpose of enlarging their establishments. As a legitimate result, the whole country projected and engaged in all manner of new industrial and financial undertakings. In Prussia alone six hundred and eighty-seven new joint-stock companies were founded during the year 1872 and the first six months of 1873, with an aggregate capital of $481,045,000. Such a state of things, as is now obvious, was most unnatural, and could not continue ; and the reaction and disaster came with great suddenness, as has been already stated, in the fall of 1873, but without anticipation on the part of the multitude. Great fortunes rapidly melted away, industry became paralyzed, and the whole of Germany passed at once from a condition of apparently great prosperity to a depth of financial, industrial, and commercial depression that had never been equaled.

In the United States the phenomena antecedent to the crisis were enumerated at the time to be, "a rise of prices, great prosperity, large profits, high wages and strikes for higher; large importations, a railway mania, expanded credit, over-trading, over-building, and high living." The crisis began on the 17th of September, 1873, by the failure of a comparatively unimportant railway company—the New York and Oswego Midland. On the 18th, the banking-house of Jay Cooke & Co. failed. On the 19th, nineteen other banking-houses failed. Then followed a succession of bankruptcies, until in four years the mercantile failures had aggregated $775,865,000; and on January 1, 1875, the amount of American railway bonds in default amounted to $789,367,655.

The period of economic disturbance which thus began in Germany and the United States soon extended to France and Belgium; and thereafter, but with varying degrees of severity, to Great Britain (i. e., in the latter months of the succeeding year), to the other states of Europe, and ultimately to the commercial portions of almost every country. The testimony before the British Parliamentary Commission (1885–'86), however, shows that the depression in Great Britain was not at once universal; but that, on the contrary, production, employment, and profits, at such great manufacturing centers as Birmingham and Huddersfield, were above the average until 1875.

By many writers on this subject, the depression and disturbance of industry, which commenced in 1873, are regarded as having terminated in 1878–'79; but all are agreed that they recommenced, with somewhat modified conditions, and even with increased severity, in 1882–'83. A full consideration of the larger evidence which is now (1887) available would, however, seem to lead to the conclusion that there really was no termination of the abnormal course of events, the marked and definite commencement of which is assigned to 1873, but that what has been regarded as a "termination" was only an "interruption," occasioned by extraordinary causes, varying locally, and by no means universal. Thus, a failure during the years 1879, 1880, and 1881, of the cereal crops of Europe and most other countries of the world, with the exception of the United States—a failure for which, in respect to duration and extent, there had been no parallel in four centuries—occasioned a remarkable demand on the latter country for all the food-products it could supply at extraordinary prices—the exportations of wheat rising from 40,000,000 bushels in 1877 to 122,000,000 in 1879, 153,000,000 in 1880, and 150,000,000 in 1881; while the corresponding values of the amount exported rose from $47,000,000 in 1877 to $130,000,000 in 1879, $190,000,000 in 1880, and $167,000,000 in 1881. There was also a corresponding increase in the quantity and value of the American exports of other cereals, and also of most meat products and provisions.* Such a demand at extraordinary prices for crops, beyond the average in quantity and quality, brought temporary prosperity to American producers, and induced great industrial and commercial activity throughout the United States ; and although the crops of other countries were notably far below the average, yet the great advance in prices undoubtedly went far to alleviate the distress of the foreign agriculturist, even if it did not in some cases actually better his condition, and increase his purchasing power of other than food-products. The extent to which the American producer availed himself of his increased purchasing power during the years under consideration is indicated by the increase which occurred in the importation of foreign merchandise on the part of the United States, namely, from $437,051,000 in 1878 to $667,954,000 in 1880, and $722,639,000 in 1882. Such an increase represented payment in part for American exports ($110,575,000 in gold and silver being imported in addition in 1881), and a corresponding demand for the products of foreign industries—the special effect on British industry being characterized by a statement from one of the witnesses before the Royal Commission (a representative of one of the districts of Liverpool), that "the depression continued until 1880, when there occurred an American boom, which temporarily lifted prices and induced activity." The testimony of other witnesses was, however, to the effect that in many branches of British industry there was no improvement of condition either in 1878, 1880, or in any subsequent year ; the Commission itself reporting (in December, 1886) that there was a general agreement among those whom it consulted, that the depression under consideration, "so far as Great Britain was concerned, dates from about the year 1875, and, with the exception of a short period enjoyed by certain branches of trade in the years 1880 to 1883, it has proceeded with tolerable uniformity, and has affected the trade and industry of the country generally, especially those branches connected with agriculture." The Commission further reports that the information received by them leads to the conclusion that "in Belgium, France, Russia, Scandinavia, Spain, and the United States," the depression has been "almost identical in its leading features with that existing in the United Kingdom."

In Germany and Belgium the reaction experienced in 1879, it is admitted, did not extend beyond 1882.

In France the condition of agricultural and other laborers continued so deplorable that the French Chamber of Deputies appointed a special commission of inquiry in 1884 with a view to devising measures for re-

* No. 1 spring wheat, which commanded $1.05 per bushel in the New York market on the 1st January, 1878, was quoted at $1.60 at a corresponding date in 1879; and at $1.39 in 1881. The corresponding advance in corn was from 45 cents per bushel in 1878 to 63 cents in 1879, and 70 cents in 1881; while the advance in mess-pork was from $7.05 per barrel in 1878 to $12.62½ in 1879, and $17 in 1881.

lief; while in Great Britain the condition of trade and industry has uninterruptedly been regarded, since 1882–'83, with great anxiety. There is a very general agreement of opinion in England and on the Continent of Europe that the years 1879, 1885, and 1886 were the worst that have been experienced in the period commencing with 1873. In England, France, and Germany, the increase or decrease in exports is popularly regarded as an indication of the condition of business, and assuming 100 to represent the exports for 1883, the decline in the value of the exports of these several countries since that year may be represented as follows: England, 1883, 100; 1884, 92·2; 1885, 88·5, a falling off in two years of 11·2 per cent. The record of France is better—1883, 100; 1884, 93·1; 1885, 92·3, a falling off of 7·7 per cent; while Germany falls behind both countries: 1882, 100; 1883, 98; 1884, 89; 1885, 87·5, a falling off of 12·5 per cent.

One point of interest which is here specially worthy of note from its bearing on the discussion of causes, is that the recurrence of the period of depression in 1882, after the favorable reaction which occurred to a greater or less extent in 1879, was quiet and gradual, as if matters were naturally again assuming a normal condition, and was not preceded or accompanied by any marked financial or commercial disturbances. On the contrary, the money markets of the world remained "easy," and were characterized, as they have ever since been, by a plethora of capital seeking investment and a low rate of interest; so that the economic disturbance since 1882 has been mainly in the nature of a depression of industry, with a renewed and remarkable decline of prices; with absolutely no decline, but rather an increase in the volume of trade, and certainly no falling off in production, as compared with the figures of 1880 and 1881, which years in the United States, and to some extent in other countries, were regarded as prosperous.

The following presentation, chronologically arranged, of brief extracts from various publications since 1872–'73, will further assist to a recollection and comprehension of the course of events since that period, and also exhibit the opinions which have been expressed at different times, respecting the "influence," "causes," and duration of the so-called "depression of trade and industry," by those who, by position or investigation, have assumed to speak with more or less of authority on the subject. And, with this intent, attention is first asked to the following retrospect of the curious experience of the iron and steel industry of the United States, as exhibited by quotations from the reports of the American Iron and Steel Association from 1873 to 1887:

1873. The year 1872 opened with an increased demand for iron in nearly all civilized countries. Prices advanced rapidly in all markets. The supply was unequal to the demand, although production was everywhere stimulated. In the United States forty new blast-furnaces were erected, and the erection of others was undertaken. The rapidity with which iron rose in price in the United States is shown by the circumstance that No. 1 pig-iron, which sold for $30.50 per ton at Philadelphia, in January, 1871, sold for $37.50 in January, 1872, and $53 in September of the same year.—*Report of the American Iron and Steel Association, November, 1873.*

1874. The reaction (in the world's demand for iron) in 1874 has been as general and decided as the advance in 1872 was unexpected and bewildering. It has been felt most severely in the United States; but in the United Kingdom, and in France and Germany, the iron industry has been so much depressed, all through the year, that many iron-works have been closed, and many others have been employed but a part of the time. The testimony of statistics, and of all calm observers, shows that prostration is greater at the close of 1874 than it was at the close of 1873, and that the general distress is greater. At least a million of skilled and unskilled working-men and working-women in this country are out of employment to-day, because there is no work for them to do.—*Report, December 31, 1874.*

1877. Since 1873 each year has shown a decrease in the production of pig-iron in the United States, as compared with the preceding year, the percentage of decrease being as follows: 1874, six per cent; 1875, fifteen per cent; 1876, eight per cent. This is a very great shrinkage, and indicates, with concurrent low prices, a very great depression in the pig-iron industry of the country. If the rate of decrease which marked the period from 1873 to 1876 were to be continued, the production of pig-iron in the United States would entirely cease in 1884, less than eight years from the present time, and our furnace-stacks would only be useful as observatories for the study of astronomy. But our pig-iron industry is not destined to come to such an untimely end, for we see that the heavy percentage of decrease which had characterized the year 1875 was not continued in 1876. It seems plain that the production of pig-iron commenced last year to rally from the effects of the panic of 1873.—*Report, June, 1887.*

1878. The year 1877 witnessed an increased demand for some of our iron and steel products, as compared with 1876; neutralized, however, so far as producers were concerned, by a very marked decrease in prices. Nor did low prices form the only unfavorable feature of the iron trade of 1877. More than one half of the furnaces, and many of the rolling-mills, were idle the whole year. Prices were so low as to warrant the opinion that they could be no lower. Hence, mainly, the increased consumption of iron in that year.—*Report, July, 1878.*

1879. In nearly all the branches of the domestic iron and steel industries there has been an increased production in 1878 over 1877; but this increase in production has been accompanied by a decrease in prices. At no time in the history of the country have prices for iron and steel been as low as they were in 1878, excepting in colonial days, when the price of pig-iron was lower.—*Report, May 6, 1879.*

1880. Near the close of 1878 it became evident that the business depression which had succeeded the panic of 1873 was slowly disappearing, and that a general revival of prosperity was at hand. The country had been favored with good crops, and short harvests abroad has caused a demand for agricultural surplus. In the spring months of 1879 the managers of the leading railroads of the country, being assured of a continued increase of their business through the unfavorable outlook for the European harvests, simultaneously began to give out orders for materials containing iron and steel. In the closing months of 1879 excitement and speculation took the place of the gloom and discouragement with which the American iron-trade had been so familiar scarce one year before, and the business of buying and selling iron became close neighbor to that of gambling in stocks.—*Report, May, 1880.*

No. 1 pig-iron, which sold for $53 per ton at Philadelphia in September, 1872, sold for $24 in 1874, $21.25 in 1876, $16.50 in 1878, $41 in February, 1880; $25 in May, 1880; $26 in 1882, $18.50 in 1884, $17.75 in 1885, and $18.50 in 1886.

1882. The year 1881 was the most prosperous year American iron and steel manufacturers have ever known.—*Report, June, 1882.*

1883. The extraordinary activity in our iron and steel industries, which commenced in 1879, culminated early in 1882. The reaction was not sudden, but was so gradual and tranquil that for some time it excited no apprehension. In November and December the market was greatly depressed. At the beginning of December, 1881, the average price of steel rails at the (American) mills was $60 per ton, but in December, 1882, the average price was only $39.* In all the fluctuations of iron and steel that have taken place in this country, we know of none so sweeping as this decline in the price of steel rails, if we except in 1879 and 1880, and many of these were entirely speculative.—*Report, May, 1883.*

The cause of this serious reaction was attributed, in the same report, in great measure to the circumstance that "we had increased our capacity for the production of most forms of iron and steel much faster than the consumptive wants of the country had increased."

1884. Since the publication of the last annual report, in May, 1883, the unsatisfactory condition of the American iron-trade, as it then existed, has not improved. It has steadily grown worse.—*Report, May, 1884.*

1887. The year 1886 was one of the most active years the American iron-trade has ever experienced. The improvement in demand which had commenced in the latter part of 1885 was well maintained throughout the whole of 1886. The production of the year in all the leading branches of the trade was much the largest in our history. The remote causes of the revival in the prosperity of the American iron-trade which began in the last half of 1885, and still continues, may be difficult to discover; but one influential immediate cause is directly traceable to the meeting of the Bessemer steel-rail manufacturers in August, 1885, at which meeting a restriction of production for one year to avoid the evils of over-production and ruinous prices was agreed upon. This action was almost immediately followed by beneficial results to the iron-trade of the whole country, and to many other branches of domestic industry. We do not forget that the revival in railroad-building which commenced in the late months of 1885, and has continued to the present time (1887), has been the influence which most stimulated the demand for iron and steel; but it was the action of the Bessemer steel-rail manufacturers which put a check to the demoralization of prices which prevailed prior to their meeting, and stimulated the managers of existing railroads to hasten their arrangements for contemplated repairs and equipments. An incident of our industrial history for 1886 was the large number of strikes among workingmen. More American workingmen were volun-

* The average price of Bessemer steel rails, which commanded $39 per ton at American mills in December, 1882, declined to $25 in 1885.

tarily out of employment in that year than in any previous year.—*Report for April, 1887.*

The following extracts from published statements and opinions are more general in their nature, but not less instructive:

1876. Our country is now passing through a period of unusual depression, both in its industries and its business. The present depressed condition of business and of financial affairs exists over all countries having a high civilization.—*Facts and Observations addressed to the Committee on Finance of the Mutual Life-Insurance Company of New York, July, 1876. Printed for the Private Convenience of the Trustees.*

1876. The inquiry has been sufficiently broad to enable them (the committee), to point out with a considerable degree of accuracy the causes which have immediately operated to produce the present depression in the commerce of the country, and in some branches of its manufacturing and mining industries. These causes are quite beyond legislative control in this country.—*Report of Select Committee of the House of Commons, Dominion of Canada, 1876.*

1877. Hard times! For four years this sober pass-word has gained in gravity of import. For a time it was panic; but suppositions of speedy recovery have given place to a conviction of underlying facts that these hard times are more than a panic; that the existing depression of trade and dearth of employment are not, in popular apprehension, exaggerated, but are the serious results of causes more permanent in their nature than is generally considered.—*Hard Times, by Franklin W. Smith, Boston, 1877, James R. Osgood & Co.*

CONGRESS OF THE UNITED STATES, HOUSE OF REPRESENTATIVES, *June* 17, 1878.

1878. Mr. Thompson submitted the following resolution, which was agreed to:

*Whereas*, labor and the productive interests of the country are greatly depressed, and suffering severely from causes not yet fully understood, etc.: Therefore,

*Resolved*, That a committee of seven members of this House be appointed, whose duty it shall be to inquire into and ascertain the causes of general business depression, etc., and report at the next session.

1878. Commercial depression is the universal cry—a commercial depression probably unprecedented in duration in the annals of trade, except under the disturbing action of prolonged war. . . . Ample evidence abounds on all sides to show its extent and severity in England. Have other countries bowed their heads in suffering under the commercial depression? Let America be the first to speak. In 1873 she experienced a shock of the most formidable kind. She has not recovered from the shock at this very hour. Let us visit Germany—Germany the conqueror in a great war, and the exactor of an unheard-of indemnity. What do we find in that country? Worse commercial weather at this hour than in any other. Nowhere are louder complaints uttered of the stagnation of trade. Austria and Hungary repeat the cry, but in a somewhat lower voice. And so we come round to France, the people whose well-being has been so visited with the most violent assaults. Her losses and sufferings have surpassed those endured by any other nation. Yet the deep, heavy pressure of her commercial paralysis has weighed upon her the least oppressive of all. Such a depression, spread over so many countries, inflicting such continuous distress, and lasting for so long a period of time, the history of trade has probably never before exhibited.—BONAMY PRICE, *Contemporary Review, 1878.*

1879. The prevailing depression in business from which this country has suffered for six years, and from which nearly every country in Europe is suffering still, has probably furnished support to a greater number of conflicting economical theories than any other occurrence of ancient or modern times. . . . The result, we need hardly say, has not been to raise the reputation of political economy as a science. In fact, it has never seemed so little of a science as during the past five years, owing to the extraordinary array of proof and illustration which the holders of the most widely divergent views have been able to produce.—*The Nation (New York), May, 1879.*

1879. We have just passed through a period of depression, of which, though it came in perfect agreement with all past experiences, was complicated by such an exceptional conglomeration of untoward circumstances, and protracted to such a weary length, that men seemed to lose faith in the revival which was almost certain to come sooner or later, and began to ask whether the commercial supremacy of this country was not permanently undermined. And now, with the new decade, the revival is really here.—*The Recent Depression of Trade, being the Oxford Cobden Prize Essay for 1879, by Walter E. Smith, London, Trübner & Co., 1880.*

1881. The industrial depression is generally thought to have commenced in the closing months of 1874, and it increased in intensity throughout 1876 and 1877.—*Professor* HENRY FAWCETT, "*Free Trade and Protection*," *London, 1881.*

1885. The present depression of trade is remarkable, not so much for its intensity or for its extent—in both of which respects it has been equaled or surpassed on previous occasions—but for its persistence during the long period of eleven years. The industrial depression is generally thought to have commenced in the closing months of 1874; and, during every succeeding year, it has continued to be felt with more or less severity, and its remarkable persistence has been commented on by politicians and public writers. Usually, a period of depression is quickly followed by one of comparative prosperity. Such a reaction has been again and again predicted in this case, but, up to the present time, there are no satisfactory indications that the evil days are passing away. It is evident, therefore, that we are suffering in an altogether exceptional manner; that the disease of the social organism is due to causes which have not been in action on former occasions, and that the remedial agencies which have been effective on former occasions have now failed us.—*Bad Times, an Essay on the Present Depression of Trade, by Alfred Russel Wallace, London, October, 1885.*

The following are notable extracts from the testimony presented to the Royal (British) Commission, appointed August, 1885, to inquire into the depression of trade and industry, and embodied in their reports submitted to Parliament in 1885–'86:

1885. At the present time, a general depression of trade and industry is stated to exist throughout Italy. While, however, depression is general, it does not act uniformly on all industries.—*Testimony of Ellis Colnaghi, Her Majesty's Consul-General at Florence, October 8, 1885.*

The depression began full ten years ago, and still continues.—*Testimony of the Linen Merchants' Association of Belfast, Ireland, November, 1885.*

The origin of the depression from which we suffer, and which is at the lowest point yet reached, seems to be a reaction from the coal-famine period of 1872–'74, and which was perhaps due to the inflation consequent on the Franco-

German War in 1870. The progress of depression has been irregular, but with a persistent downward tendency since 1874. The present tendency is still downward.—*Testimony of the North of England Iron Manufacturers' Association, September, 1885.*

The depression has been increasing in intensity during the last four years. It was probably never greater than at present at this season of the year.—*Testimony of the British Paper-Makers' Association, September, 1885.*

Trade began to be depressed in 1876, and has continued so till the year 1883, with intermittent spurts of improvement But from the end of 1883 the depression has become increasingly acute.—*Testimony of North Staffordshire Chamber of Commerce, October 21, 1885.*

As a proof of the deplorable state this trade [woolen-yarn spinning, Huddersfield, England] has been in for the last ten or fifteen years, we most respectfully beg to inform you, we hold the list of fifty firms of spinners who have been ruined and brought into the bankruptcy court during that period. Another proof of the very serious state of trade here is to be found in the depreciated value of carding and spinning machinery. Good machines, and for all practical purposes equal to new, if brought into the market will only realize some thirty or forty per cent of their cost price. Mill property is also in a similar position.—*Report of the Huddersfield (England) Chamber of Commerce, October, 1885.*

1886. Out of the total number of establishments, such as factories, mines, etc., existing in the country [the United States], about eight per cent were absolutely idle during the year ending July 1, 1885, and perhaps five per cent more were idle a part of such time; or, for a just estimate, seven and a half per cent of the whole number of such establishments were idle, or equivalent to idle, during the year named. . . . Making allowance for the persons engaged in other occupations, 998,839 constituted "the best estimate" of the possibly unemployed in the United States during the year ending July 1, 1885 (many of the unemployed, those who under prosperous times would be fully employed, and who during the time mentioned were seeking employment), that it has been possible for the Bureau to make. . . . A million people out of employment, crippling all dependent upon them, means a loss to the consumptive power of the country of at least $1,000,000 per day, or a crippling of the trade of the country of over $300,000,000 per annum.—*Report on Industrial Depression, United States Bureau of Labor, 1886.*

1886. It may be remembered that about twelve months ago there were evidences of an improved feeling in the English iron-trade. This was caused by the news of improvement in America; but this better feeling soon passed away, and was succeeded by even a deeper depression and lower prices. . . . On examining the Board of Trade returns, it is disappointing to find that any improvement in our exports is confined almost exclusively to the United States, and that many of our principal customers have been taking less than formerly. This, however, may be explained by the depression which has hung over other countries in common with our own.—*London Statist, November, 1886.*

1886. The present crisis has a much more general character than any of the crises which have preceded it; because it is a part of an abrupt transformation in the production and circulation of the whole world. For the same reason, it is destined to last longer.—M. Leroy Beaulieu, *Revue des Deux Mondes, 1886.*

1887. It is pretty well known that the late revival in the English iron-trade was largely, if not exclusively, due to an increased demand from the United

States, which set in during the latter part of 1886, there being no increase in our exports to other countries.—*London Economist, April, 1887.*

The *octroi* receipts of the city of Paris from taxes levied at the gates on articles of food, coal, and building materials, which are the barometer of trade in the metropolis, contrast unfavorably with last year.—*Ibid.*

It is of interest to note how few, relatively, of the staples, raw materials or finished products, have left the year 1886 with any special gain in price as compared with one year or with two years ago, and it is even mere striking to enumerate the list of those which show actually no gain at all, or a loss in price.—*Bradstreet's Journal, January, 1887.*

Wheat, oats, sugar, butter, tobacco, and petroleum were lower in price at the close of 1886 than at the close of 1885. Corn, oats, pork, lard, and cotton were lower at the close of 1886 than at the begining of 1885.—*Ibid.*

The tables of the London "Economist" also represent but a very slight gain in the index number representing the combined prices of twenty-two leading commodities on the English market for the quarter ending March 31, 1887, as compared with the corresponding quarter from the three preceding years, "the gains being mostly articles not of first-class importance."

It is almost unnecessary to say that a subject of such transcendent importance, and affecting so intimately the material interests alike of nations and individuals, has naturally attracted a great and continually increasing attention throughout the whole civilized world, entailing at least one notable result, namely, that of a large and varied contribution to existing economic literature. Thus, State commissions for inquiring into the phenomena under consideration have been instituted by Great Britain, the United States, France, Italy, and the Dominion of Canada, all of which have taken evidence and reported more or less voluminously; the report of the Royal British Commission (1885–'86), comprising five folio volumes of an aggregate of about 1,800 pages; and that of Italy (1886), fifteen volumes with appendices; while the books, pamphlets, magazine articles, and reviews on the same subject, including investigations and discussions on collateral matters regarded as elements or results of the economic problem (such as the wide-spread ferment and discontent of labor, and the changes in the monetary functions of gold and silver), which have emanated from individuals or commissions, have been sufficiently numerous to constitute, if collected, a not inconsiderable library.

In all these investigations and discussions, the chief objective has been the recognition or determination of causes; and most naturally and legitimately, inasmuch as it is clear that only through such recognitions and determinations can the atmosphere of mystery which to a certain extent envelops the phenomena under consideration be dispelled, and the way prepared for an intelligent discussion of remedies. And on this point the opinions or conclusions expressed have been widely and most curiously different. Nearly all investigators are agreed that the wide-spread and long-continued "depression of business" is referable not to one but a variety of causes, which have been more or less influential; and among such causes the following are generally regarded as having been especially potential: "Overproduction"; "the scarcity and appreciation of gold," or "the depreciation of silver, through its demonetization"; "restrictions of the free course of commerce" through protective tariffs on the one hand, and excessive and unnatural competition occasioned by excessive foreign imports contingent on the absence of "fair" trade or protection on the other; heavy national losses, occasioned by destructive wars, especially the Franco-Prussian War; the continuation of excessive war expenditures; the failure of crops; the unproductiveness of foreign loans or investments; excessive speculation and reaction from great inflations; strikes and interruption of production consequent on trades-unions and other organizations of labor; the concentration of capital in few hands, and a consequent antagonizing influence to the equitable diffusion of wealth; "excessive expenditures for alcoholic beverages," and a "general improvidence of the working-classes." In the investigations undertaken by committees of Congress in the United States, the causes assigned by the various witnesses who testified before them were comprised under no less than one hundred and eighty heads; and an almost equal diversity of opinion was manifested by the witnesses who appeared before the Royal (British) Commission.* The special causes to which a majority of the Commission itself attached any great degree of importance, stated in the order presented by them, are as follows: 1. Changes in the distribution of wealth—i. e., in Great Britain; 2. Natural tendency to diminution in the rate of profit consequent on the progressive accumulation of capital; 3. Overproduction; 4. Impairment of agricultural industry consequent on bad seasons, and the competition of the products of other soils which can be cultivated under more favorable conditions; 5. Foreign tariffs and bounties and the restrictive commercial policies of foreign countries; 6. The working of the British Limited Liability Act. In addition to these special causes, others of a general character were mentioned; such as "the more limited possibilities of new sources of demand throughout the world, and the larger amount of capital seeking employment"; "the serious fall in prices"; "the appreciation of the standard of value" so far as connected with the fall of prices and foreign competition. A respectable minority of the commission also included, in the list of principal causes, the effect of British legislation, regulating the hours and conditions of labor on the cost of production

* The Birmingham Chamber of Commerce attributed it in great part to German and Belgian competition, to foreign import duties on home-manufactured goods exported abroad, and exorbitant railway rates; the Hartlepool Chamber to foreign competition; Manchester, the same; Leeds, "to foreign tariffs"; Liverpool, to a loss in a once large re-export trade in cotton; Wolverhampton, to changes in the hours of labor resulting from the operation of the Factory, Workshop, and Education Acts, and the action of the various trades-unions.

as compared with other countries; and the discriminations given by British railways to foreign producers in the conveyance of goods.

It would seem as if one could not acquaint himself to any considerable extent with the great body of literature on this subject of the recent depression of trade, without becoming impressed with the tendency of many writers and investigators of repute, and of most of the persons who have given testimony before the commissions of different countries, to greatly magnify the influence of purely local causes. "The real and deep-seated cause of all our distress," says the "Oxford Prize Essay" for 1879, "is this: the whole world has been consuming more than it has produced, and is consequently in a state of impoverishment, and can not buy our wares."

Nearly all British writers dwell upon the immense losses to British farming capital, contingent upon deficient crops since 1875, and the decline in the value and use of arable land in the United Kingdom, and concurrent decline in the price of agricultural produce, due to foreign competitive supplies, as prime factors in accounting for trade depression; while, throughout much of the testimony given before the British Commission by British manufacturers and merchants, the injurious influence of hostile foreign tariffs on the exports of British manufactures, and the competition of foreign manufactures in the British home market, are continually referred to as having been especially productive of industrial disturbance. In France, the principal assigned causes are, excessive speculation prior to 1873, followed by bad crops; the great falling off in the production of wine through the destruction of vineyards by the phylloxera; a serious depression of the silk-trade industry; the disappearance of sardines and other fish from the coast of Brittany; excessive taxation; excessive increase in manufactured products; and restricted markets due to the competition of foreign nations paying less wages. In Italy a succession of bad crops, a disease among the silk-worms, and a stagnation of the silk industry, are prominently cited; while in Denmark, bad harvests, a disturbed state of internal politics, an alteration in the metallism of the country in 1873, and general over-production of manufactured products, are popularly assigned as sufficient causes.

Excessive taxation upon trade and industry, as a leading cause of trade depression, has also found strong advocacy, and the evidence brought forward is certainly impressive. The present annual burden of taxation in Europe for military purposes at the present time is estimated at about £170,000,000 ($850,000,000). In France, the complaints as to the pressure of taxation on industry are universal. The imperial taxation in 1884 was reported at £120,000,000 ($600,000,000) on a population of 37,000,000. Local taxation in France is also very heavy, the *octroi* duties for Paris alone for the year 1884 having amounted to 139,000,000 francs ($27,800,000), in addition to which were other heavy municipal taxes, as, for example, on carriages, horses, cabs, dogs, market-stalls, funerals, clubs, canals, the keeping of shops, and other commodities and occupations.—*Testimony of J. A. Crowe, British Commission.*

In Italy, according to the British consul-general at Florence (British Commission), the income-tax in 1884 was above thirteen per cent, and the land-tax in some instances as high as twenty-five per cent upon the gross rental. These are independent of local taxation, included in which is the *octroi*, which is also described as "very onerous, and, not being confined to articles of food only, have raised a quantity of small internal barriers, which, in a minor degree, replace the customs barriers of the several small states into which the country was formerly divided."

In respect to Great Britain, the British Commission, as the result of their investigations into this matter, says: "Of the fact of the increase, especially of local taxation, there is no doubt. At the same time it will probably be found that, relatively to the population and wealth of the country, the burden of taxation is now far lighter than in any previous periods."

The published opinions of certain persons of note on the subject are also worthy of attention. Mr. Alfred Russel Wallace, in his book entitled "Bad Times," London, 1885, expresses the opinion that among the most efficient causes for the current depression of trade are "wars and excessive armaments, loans to despots or for war purposes, and the accumulation of vast wealth by individuals."

Dr. Wirth, of Vienna, finds a like explanation in the excessive conversion, or rather perversion, of private wealth for public purposes. Dr. Engel, of Berlin, regards the millions wasted in war by France and Germany, from 1870 to 1871, and continued and prospective expenditures for like purposes, as culminating causes of almost universal business calamities; while, in the opinion of Professor Thorold Rogers, the scarcity and consequent dearness of gold have been the factors of chief importance.

But side by side with all the theories that the "depression" has been occasioned by the destruction or non-production of vast amounts of property by wars, bad harvests, strikes, loss of capital by employment in worthless enterprises, the conversion of an undue amount of circulating capital into fixed capital, and extravagant consumption, should be placed the facts, that statistics not only fail to reveal the existence of any great degree of scarcity anywhere, but, on the contrary, prove that those countries in which depression has been and is most severely felt are the very ones in which desirable commodities of every description—railroads, ships, houses, live-stock, food, clothing, fuel, and luxuries—have year by year been accumulating with the greatest rapidity, and offered for use or consumption at rates unprecedented for cheapness. If lack of capital, furthermore, by destruction or perversion had been the cause, the rate of profit on the use of capital would have been higher; but the fact is, that the rate of profit on even the most promising kinds of capital during recent years has been everywhere exceptionally low.

Another notable tendency among investigators is to assign to clearly secondary causes or results, positions of primary importance. Thus (general) over-production,* or an amount of production of commodities in excess of demand at remunerative prices, finds greater favor as an agency of current economic disturbance than any other. But surely all nations and people could not, with one accord and almost concurrently, have entered upon a course of unprofitable production without being impelled by an agency so universal and so irresistible as to almost become invested with the character of a natural law; and hence over-production obviously, in any broad inquiry, must be accepted as a result rather than a cause. And so, also, in respect to "metallism" and the enactment of laws restrictive of commerce; for no one can seriously suppose that silver has been demonetized or tariffs enacted inadvertently, or at the whim and caprice of individuals, with a view of occasioning either domestic or international economic disturbances; but, on the contrary, the only reasonable supposition is, that antecedent conditions or agencies have prompted to action in both cases, by inducing a belief that measures of the kind specified were in the nature of safeguards against threatened economic evils, or as helps to, at least, local prosperity. And as crop failures, the ravages of insects, the diseases of animals, the disappearance of fish, and maladministration of government, are local and not necessarily permanent, they must all clearly, in any investigation, be regarded as secondary and not primary agencies. In short, the general recognition, by all investigators, that the striking characteristic of the economic disturbance that has prevailed since 1873 is its universality, of necessity compels a recognition of the fact that the agency which was mainly instrumental in producing it could not have been local, and must have been universal in its influence and action. And the question of interest which next presents itself is, can any such agency, thus operative and thus potential, be recognized? Let us inquire.

* No term has been used more loosely in the discussion of this subject of trade depression than that of "*over-production*." The idea that there can be such a thing as a general production of useful or desirable commodities in excess of what is wanted is an absurdity; but there may be, as above stated, an amount of production in excess of demand at remunerative prices, or, what is substantially the same thing, an excess of capacity for production; or the term may be properly used to indicate a check on the distribution of products consequent on the existence of such conditions.

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Professor Ferdinand Cohn, in a paper on "Vital Questions," considers that we have half solved the riddle of life, inasmuch as we have grasped its mechanism and the physical and chemical forces that set it in motion. But as we still have to face other phenomena and active forces, the full solution of the problem is yet far deferred.

# THE TASK OF AMERICAN BOTANISTS.*

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IN discussing the question, What sort of botanical investigation is needed in this country? one might consider two things: First, what are the special problems which from their nature can be studied better in this country than elsewhere; and, secondly, what kind of investigation is best adapted to the present state of our botanical establishments and the capacities of the botanists of this country? In the former case, we are simply to endeavor to contribute something new to the stock of the world's knowledge. In the latter case we shall attempt also to raise the standard of work in this country to that of countries in which botany has reached its highest development. Of these two considerations, the second is, perhaps, the more urgent, because, granting that there are botanical problems which could be solved more easily by botanists living in this country than by Europeans, they will remain unsolved unless our botanists have the time, the means, and the preliminary training for the work. Let me mention a case in point. For many years, botanists wished to know the development of *Azolla*, a genus not found in Europe, but represented in this country by a species common in several districts comparatively near some of the centers of botanical instruction. Naturally, we should have looked to our own botanists for the study of this interesting subject; and it is not flattering to our national pride that the development of our own species of *Azolla* was first made out, not by an American, but by a Swede working at a disadvantage. Other instances might be given in which questions that ought to have been settled by Americans were solved by foreigners. If we are behind some other nations in the quantity and quality of our botanical investigations, what is the reason? Possibly it is not the fault of our botanists, but rather the peculiarity of the conditions under which they are placed; and it would be well, before going further, to consider some of the difficulties which are in the way of those who would like to pursue botanical investigations, for, if some of them are inevitable in the present stage of our scientific development, it may be that others are of our own creation and might be removed.

If, then, we are not doing as much in the way of investigation as other nations, it must be either through lack of inclination, lack of time, lack of means, or lack of the requisite training. I am not inclined to believe that a lack of inclination is responsible for much of the trouble. We have our full share of persons who prefer an inactive self-culture to active work in any special direction, but we also

* Read before the American Society of Naturalists, Philadelphia, December 29, 1886.

have a sufficiently large body of energetic botanists who would gladly do original work if they could. Neither can a lack of requisite training, I think, be regarded as the main obstacle in the way of research. It is true, to be sure, that it has been a serious obstacle in many cases, but it need not be hereafter. If we have not so many well-equipped laboratories of research, so many large libraries and collections as are to be found in European countries, we do have a number of botanical and biological establishments where a student can acquire the training necessary to prepare him for good, original work in botany. However desirable it may be, it certainly is no longer necessary that a young man should go to France or Germany in order to prepare himself for independent work. The great advantage to be obtained from a course of study abroad is the stimulus derived from association with those who devote most of their time to research, as is common in Germany; but, so far as acquiring merely the technical details necessary to one who would carry on independent work or the general knowledge of vegetable morphology, physiology, and histology, which must precede special work in every case, there certainly are laboratories in this country which are quite sufficient for the purpose. Whether a student who can afford to study abroad had not better do so in preference to remaining at home is, of course, another question, and has nothing to do with the fact that one can get a good preparation for work here. If one wishes to pursue botanical investigation, it is his own fault if he does not fit himself for the work by thorough training, unless, indeed, he is too poor; and neither in this country nor any other is it ever going to be possible for one without some pecuniary resources to obtain a training in any branch of science unless he happens to be a person of extraordinary ability.

The two most serious obstacles in the way of research in this country are the want of time and means among those who are mentally well equipped for the work, and who would gladly pursue special investigations were it possible. The lack of time and lack of means are closely related, and, in this country, are unfortunately often found together. If a botanist were only wealthy, he could, of course, find time for research. But, when I speak of lack of means, I refer not to an absence of individual wealth—for we all know that our active botanists have been, and probably always will be, of a class in society only comfortably well off, at the best—but rather to the lack of laboratory equipment, suitable assistants, means of publication, etc. It is an unfortunate fact, too, that those who have the most time at their disposal are usually those away from laboratories and libraries, while those who, like the instructors in the richer colleges, have access to good laboratories and libraries, have to spend most of their time in teaching. Of the two, lack of time and lack of means, I am inclined to believe that the former is the more of an obstacle in the way of research, since it is possible for an energetic, well-trained botanist to do a good deal even with comparatively poor means; but a well-equipped laboratory, and extensive collections and libraries, are of no avail to him who has not the time to use them. The best work ought to be expected of professional botanists—that is, those attached to the schools and colleges as professors and instructors, rather than from private individuals giving some of their time to botany, because the professors are supposed to be selected for their special knowledge of and interest in botany, and to have better means for work than any, except wealthy private individuals. But if the professors do not accomplish as much as is expected in the way of investigation, their principal excuse—and it is a good one—is that they have no time. But the day is as long in America as it is in Germany, it will be said, and the American professor ought to find time for original work. Unfortunately, most if not all his time is spent in class-work; and his laboratory, his books, his collections, are largely used in elementary instruction of beginners in botany. For this abuse of time and material the public are in part to blame, but, to a considerable extent, the botanists themselves are responsible for the present state of things. In the good old days, the few botanical professors in this country were looked upon as an amiable, harmless set of men who were allowed to give a few lectures every year, and beyond that they were left severely alone. They had an amount of leisure for undisturbed work unknown to the modern professor, and there can be no doubt that their work in investigating our flora did far more for botany in this country than any amount of class-work which they might have done.

But now it is all changed. From being neglected, botany has become a popular study; and it is not enough that a professor should give a course of lectures, but he must have laboratory classes and be prepared to demonstrate the very latest European experiments. If the public now expect far more in the way of personal instruction from botanical professors than they used to, it is largely owing to the fact that botanists themselves have for years been urging the importance of botany as a help in education, and, until recently, have neglected to lay sufficient stress on the value of original work. The educational value of botany is pretty well recognized by the public, and, judging by the last few years, they are rather liberal in providing the means for class-instruction. When it comes to providing the means of research, the question is different; and the trouble is not so much that the public do not really appreciate a good piece of botanical work when their attention is called to it, as that they, as yet, have not the least idea of the amount of time and money required to prosecute research successfully. The unscientific public have an idea that research is a thing of inspiration, or perhaps a sort of recreation to be indulged in after class-work is over, and no conception of the months, and even years, of drudgery required before anything of value is really in print. Not infrequently they regard the ordinary student in a botanical course as a co-worker with the professor. It has often happened that enthusiastic persons have said to me, "How delightful it must be to have a class of students aiding you in your researches!" Alas! why could they not see that they were hindrances, not aids?

Furthermore, for some most unaccountable reason, the public have the impression that research pays for itself, and therefore does not require endowment. Probably a good many of my hearers have heard the remark, "I suppose you must make considerable out of your scientific papers." Unfortunately, with the exception of text-books of a lower grade, one is only too glad not to be money out of pocket. I fear that you can all bear witness that, with rare exceptions, your published papers have never paid for themselves. It is only after the results of research have reached a homœopathic dilution in some text-book or popular article that they begin to pay. Of such dilutions we already have an abundance, and the more important point is to get something new which will bear dilution. Unfortunately, the public do not clearly see the difference between the original work and the dilution. The former does not pay, and needs encouragement; the latter is a commercial article having a recognized money-value.

A part of the confusion with regard to the paying-value of research in natural history is probably due to the fact that the public see that certain discoveries in physics and chemistry are pecuniarily profitable. But in natural history there are no truths which can be patented. Biological discoveries become the property of the world if the discoverer is fortunate enough to have his work published.

A great gain will have been made if the public can be persuaded that professors in colleges ought to be allowed time for, and be expected to do, original work; and we should assure them that such work is of real value to the world. If the professors are to have time, it can only be by giving them a number of assistants who will relieve them of all the details of laboratory instruction, and possibly the elementary lectures. More advanced work could probably be secured by having one professor with a number of assistants than by two professors without any assistants, provided they both have to give laboratory instruction, as is probable. In a paper which I read to the society at its last meeting, I stated incidentally that one assistant was not enough for a class of thirty or forty men. I did not dwell on the subject at the time, as it was only indirectly related to the question then discussed; but since then a number of persons have expressed their regrets that I had not put the case more strongly, for they regarded an increase in the number of assistants as essential to good instruction and work. It is desirable that there should be an assistant for every twelve students in a laboratory, and it is necessary that there should be one for every twenty men if the work is to be well done. If there are forty students and one assistant, then the professor himself must act as an assistant to twenty of the men, and that means cutting short the time for other work. In Germany they manage the thing better. The ordinary laboratory work is in the hands of assistants, and the professor, besides his lectures, gives his time to advanced students and original work. The question is, Can our colleges pay for more assistants? They have hard enough work to pay the professors, as a rule, but if the public could be made to see the real need of assistants, and recognize the fact that a professor's salary is not large enough for him to pay for assistance out of his own pocket, perhaps, sooner or later, the money might be provided. As far as the professors and instructors in schools and colleges are concerned, they are not so well able to do original work as formerly, owing to the more laborious methods of modern instruction; but it may be that we are in a stage of transition, and that before long the possibility of overdoing instruction to the detriment of research may be felt by those in charge of institutions of learning.

It may be suggested as a possible solution of the difficulty that there should be some professors for teaching and others for research. That is all very well, if you are not going to give all the money to the one who does the teaching. There is a tendency to regard any salary, no matter how small, as large enough for one who is engaged in research, and the reason usually assigned is absurd, viz., that investigators prefer investigation to any other work. It seems preposterous that the fact that a man's heart is in his work should be made a pretext for paying him less for his work! There are those who prefer teaching to research, and are they paid any the less because they like their teaching? Of the two, the instructor and the investigator, the latter has the more frequent professional calls on his purse even in well-equipped colleges, and statistics are wanting to show that investigators have smaller families to provide for than teachers.

Having considered some of the difficulties in the way of research, we can return to the original question. What sort of botanical investigation is needed in this country? Whatever may be the case in physics and chemistry, it is a fact that the study of natural history in any country passes through stages of development much the same everywhere. In a new country the first work must be almost entirely descriptive and classificatory; and, when this work has reached a sufficiently advanced stage, histology, physiology, and study of life-histories assume more and more importance. In most European countries the first stage has been long past, except as far as some of the lowest forms of plants are concerned, and the greater part of the best work of France and Germany at the present day relates to physiological and developmental subjects. Where do we stand? The question is important, because there is not infrequently a tendency to assume that work in this country is of value only in so far as it is on the same plane and of the same kind as work in Europe. We must be contented to wait a little while, and we do harm rather than good if we teach that there is no work worth doing except that done in the laboratories of Germany. It often seems as if we were producing a set of precious little prigs, when one sees young men turning up their noses at all those who do any work not involving the most complicated microscopical manipulations. It is well to have our standard high, but it should not be unattainable. We may well set before our young men such models as De Bary, Sachs, Strasburger, and others; but it is just possible that a young man who is determined to be a De Bary, a Sachs, a Strasburger, or nothing, may have to adopt the latter alternative. The trouble is, too many young men assume that the work which they are destined to do is of the highest grade, and they expect to be provided with all the refined apparatus and complete equipment which the leaders of botany abroad possess. They will not begin the simplest thing without an array of reagents which would be the envy of a good many chemists, and the number of staining-fluids which they must have around them would make the rainbow blush at its own poverty. One young man thinks he can't do any work because he has not a Jung microtome. Another has been unable to do anything during a vacation at the sea-shore because he had no osmic acid. To such persons one is inclined to say that he would be thankful if they would *do* anything.

As far as the kind of investigation needed in botany is concerned, we stand where Germany formerly stood, not where she now stands. It is of no use to say that descriptive systematic work is not highly rated in Germany. Our country is so large, and some parts of it are so little explored, that descriptive work has by no means reached its limit. The only question is, how to have it well done; and this brings us to a consideration of the comparative advantages of systematic work and histological and developmental work for different classes of workers. One weak point in our botanical work has been that too many persons have attempted to write on descriptive subjects. Strange as it may seem to some ears, it appears to me that histological and developmental work is what is best adapted for non-professional botanists, including those who do not devote their whole time to the subject, and who as a rule have not sufficiently complete libraries and herbaria to enable them to do descriptive work well. This does not apply, of course, to the older generation of botanists, few of whom have had the training necessary for histological work, but it does apply to the younger generation. Inasmuch as the larger libraries and collections are in the colleges and larger cities, descriptive work, if it is not to be shabbily done, must be done by persons connected with colleges, or by those who are so situated that they can easily visit herbaria and libraries. Furthermore, descriptive work should be in the hands of a comparatively few experts, for long experience is necessary to a good result; whereas the questions in histology, physiology, and development are very numerous, some of them of small range, and could be done well by careful, conscientious workers, without a long experience and without extensive libraries. As far as equipment is concerned, there are, of course, subjects in physiology which require the elaborate apparatus found only in large botanical establishments, but there are others which do not. The botanist who declares that he can not do physiological work because he has not a large amount of apparatus, would do well to recall the case of a Mr. Charles Darwin, who published something on the power of movement in plants.

If the formal publication of descriptions of new species had better be left to a few experts, the collection of material must be accomplished mainly by those who are not connected with colleges, and who are not in a position to profit by large libraries and herbaria, and we have to consider one very perplexing question, viz., How can collectors receive a suitable recognition of their work? The sneering remark, "He is only a collector," is in many cases grossly unjust. In a large part of our country, the work must for some time to come consist in the discovery of the plants not before known, or not well known, and in such regions the work of the collector is just what is wanted. The man who with a keen eye goes into the field and collects, making discriminating notes on the habits and relationships of plants, is doing a very valuable service for science, and is as truly a botanist, in the best sense of the word, as he who, differently situated, writes descriptive monographs or pursues histological or physiological work. The temptation is for a person who, from his surroundings, ought to be a collector, to suppose that he should go further and attempt to describe the species he has found—a task which, as I have already said, can not well be performed away from large libraries and collections. For one, I honor those active and intelligent men and women who, isolated from the botanical centers, bring together the material of which, in the future, books and monographs are to be made. It is not enough to call them merely collectors. They are botanists in full standing.

If I have said that descriptive botany can be studied best by persons attached to the colleges and the comparatively few experts who have access to large collections and libraries, I by no means think that botanical research in colleges should be limited to this field. The one department in which we are already entitled to hold up our heads and say, "We are as good as anybody," is systematic phænogamic botany. In every other department we are behind hand, and must hurry if we would catch up with our more advanced transatlantic brothers. If I have spent some time in defending the claims of systematic botany, it was because the rising generation have developed an unwarranted contempt for such work. The claims of vegetable physiology on our young men are very great; and when we consider that, as a nation, we are noted for our inventive powers and fondness for studies having a practical bearing, it seems a little strange that vegetable physiology has not had a larger number of followers with us. Possibly the attractions of physics and chemistry have drawn away some who might have done good work in physiology. I fear that in this department, as in some others, there is a tendency to delay beginning until a first-class equipment has been provided, unmindful of the fact that good work has been done by some who had few costly instruments. Evidently, in the future, physiology is to play a more and more important part in botany, and, as the subject is one which has attractions for the public, they could probably be induced to provide the necessary instruments. It is to be hoped, however, that, in asking for a proper outfit, liberally disposed persons will be given to understand that it is to be used for work and not for ordinary class instruction. Certainly, if the colleges are to keep pace with the times, they must pay more attention to physiology than they now do. It is too much to expect that many of them should be able to support laboratories for physiological research, but we ought to have at least half a dozen such laboratories in the country. We shall probably have to do as they do abroad, where some universities pay particular attention to physiology, while others devote their main strength to other departments of botany.

If we should look to college professors and a few experts for what we still have to be done in systematic botany, and to those connected with the more important laboratories for physiological work of the higher grade, histology and the study of life-histories are subjects of vast extent, and, in most of their phases, can be studied successfully by private individuals as well as by professionals. Especially in the matter of life-histories, persons living in the country, or on the sea-shore, are often more favorably situated than those obliged to reside at the large colleges for the greater part of the year. Since for some years to come the opportunities for research on the part of college instructors must be limited by the excessive and unreasonable amount of ordinary class instruction imposed on them, we must look to non-professionals, to a large extent, to accomplish the work of research necessary to raise us to the level of foreign investigators in the departments just named. The proper direction and utilization of the work of amateurs is of especial importance in this country. The amateur abounds more with us than in any other country with the exception of England. We have an immense variety, from the gay and gallant young man who is going to do something for science, but who now can barely pay his club expenses in winter and run a steam-yacht in summer, down to the impecunious ignoramus who informs you that he is going to write a book, to include all the fungi of this continent, and coolly asks you to give or lend him all your books and specimens, and tell him how to begin. We have the male bore, who kills our time by forcing us to help him kill his; and a copious supply of mild-eyed, sweet-tongued women, whom we can not scold, because they are conscientious, and whom we can not get rid of, because they really have no other amusement. But the botanist has a slight twinge of conscience when he thinks that the kinds of amateurs of which I have spoken are tolerated mainly in the hope, sweet but prolonged, that they may contribute funds to some botanical endowment. But, alas! the gold-mills of the amateurs grind slowly, and they grind exceeding small. The large sums seldom come from amateurs, but generally from hard-headed business men who do not pretend to be botanists, but who, with a liberality which does infinite credit to us as a nation, give their money for the public good. It is superfluous for botanists to express their admiration of this class of liberal men. We more than admire them —we live on them!

But, fortunately for botany in this country, we have many amateurs of another class. We have many men and women, rich in intelligence, but usually not rich in money. They are scattered all over the country. They are to be found on the coast of New England, in the smaller towns of the West and South, and in the still more recently settled coast of the Pacific. The time which they can spare from their necessary and not unfrequently arduous occupations is given with enthusiasm to botanical pursuits. The spare money which they can command is spent on botanical books which they read. Their collections do not lie idle on the shelves. It is such amateurs as these of which we may justly be proud, and it is by their labors that a large, if not the largest, share of our botanical investigations must be made in the near future, and it is of the greatest importance that their energy and enthusiasm should not be misdirected. In the remoter districts, as I have said, the absorbing work, for some time to come, must be the collecting of specimens and the accumulation of field-notes. In the older parts of the country, including even the Mississippi Valley, it seems to me that the rising generation would make the best use of their opportunities by working out some of the many important questions of histology, and in studying the life-histories of different plants, more especially cryptogams. But the main point is, not to attempt to do too much. The thorough investigation of a small point has a definite value, and does credit to the investigator, but elaborate monographs and far-reaching physiological investigations are only of value when well done, and it is mild praise to say of a man that he has done his work "pretty well, considering," for the really wise man would have considered what he could do well as distinguished from what he could not do well.

But you will probably think that this paper is not like a ball of twine, which, however much it may be twisted and snarled, really has an end. There is much more which I should like to say on the subject; as it is, I have tried to avoid particular specifications as to the subjects of research, which would be interesting only to botanists, but to state broadly some of the difficulties in the way of botanical research, and to indicate the path which promises to be most favorable in the future. If my life proves to be as long as your patience, there will be plenty of opportunities hereafter to consider some points which I have been unable to touch upon to-day.

## VARIATIONS IN HUMAN STATURE.

By M. GUYOT DAUBÈS.

THE study of human stature involves several questions of more important interest than that of mere theory or curiosity. It may aid us in learning whether the human race is really degenerating, as some persons assert, by determining whether our ancestors in heroic and prehistoric times had the superior physical prowess that is often ascribed to them. It should teach us whether there are races of dwarfs and of giants, and what are the distances separating the races that most nearly approach those descriptions. We learn from it the exact facts respecting the differences in stature among the people of a single nation, our own, for instance, to which military men attach high value. Other fields of inquiry, of a practical bearing, regard the causes that influence the stature of populations and races in general, and the growth of individuals, from infancy up; and the influence of stature upon the force, agility, endurance, and physical development of individuals. An opinion was current, in the last century, that our ancestors, at some time in the past, were the equals or superiors in size to the largest men now to be found. M. Henrion presented to the Académie des Inscriptions, in 1718, a memoir on the variations in the size of man from the beginning of the world till the Christian era, in which Adam was given one hundred and twenty-three feet nine inches, and Eve one hundred and eighteen feet nine and three fourths inches. But after the first pair, the human race, in his imagination, suffered a regular decrease, so that Noah was only one hundred feet high, while Abraham shrank down to twenty-eight feet, Moses to thirteen feet, the mighty Hercules to ten feet eight and a half inches, and Alexander the Great to a bare six feet and a half. The communication, it is said, was received with enthusiasm, and was regarded, at the time, as a "wonderful discovery" and a "sublime vision."

The complaint about the degeneracy of the human race is not new, but dates as far back as the time of Homer, at least; for the men of his day were not like the heroes of whom he sang. It is not confirmed, but is contradicted by all the tangible facts, and these are not a few. Human remains that are exhumed, after having reposed in the grave for many centuries, as in the Catacombs of Paris, have nothing gigantic about them. The armor, the cuirasses, and the casques of the warriors of the middle ages, can be worn by modern soldiers; and many of the knights' suits would be too small for the cuirassiers of the European armies; yet they were worn by the selected men, who were better fed, stronger, and more robust than the rest of the population. The bones of the ancient Gauls, which are uncovered in the excavations of tumuli, while they are of large dimensions, are comparable with those of the existing populations of many places in France.

The Egyptian mummies are the remains of persons of small or medium stature, as are also the Peruvian and Mexican mummies, and the mummies and bones found in the ancient monuments of India and Persia. And even the most ancient relics we possess of individuals of the human species, the bones of men who lived in the Tertiary period, an epoch the remote antiquity of which goes back for hundreds of centuries, do not show any important differences in the sizes of the primitive and of the modern man.

Considerable differences will be found to exist, when we compare the statures of the various races of mankind; and it is the exaggeration of this fact that has given rise to the legends of dwarf and giant peoples. Individuals of the supposed dwarf races would appear quite large if compared with real dwarfs. A dwarf much over three feet high begins to lose interest as a dwarf; if he reaches four feet and more, he ceases to be a dwarf, and becomes a "little man." Now, the well-shaped adults of the smaller human races always, with very few exceptions, exceed four feet in height. These races are not, therefore, dwarfs, but simply small races. It is, nevertheless, interesting to study them, and compare them with the larger races. So, in these latter races, men much exceeding seven feet are exceptional, and merit the name of giants. Still, the average of stature in these larger races is much more considerable than in the smaller races; and a man of the average size, among them, would be a giant compared with an average specimen of the smaller races.

Among the smaller races are the Esquimaux, averaging five feet, two inches; the Lapps—men, five feet one inch, women, four feet seven inches; the Akkas seen by Schweinfurth in Africa; the Negritos of the Philippine and Andaman Islands, and Malacca; the dwarf race of Madagascar; and the Bushmen, whose height ranges from four feet five inches to four feet six and three fourths inches.

Among the large races may be mentioned the Norwegians, the Canadians, the North American Indians, the Caffres, the Patagonians, and the Polynesians, the average height of the last two of which is estimated at about six feet. The difference in the mean height of the various human races is, therefore, that between four feet five inches and six feet, or one foot seven inches. The mean between these two numbers is about five feet three inches; and this standard is generally agreed upon by anthropologists as a division line in the approximative classification of the races according to their height. Those are called medium races which average from five and one fourth to five and a half feet; small races, which are less than five and one fourth feet; and large races, which are more than five and a half feet in height.

From time to time there are found in different populations individuals whose stature departs much from the mean, either in excess—"giants"—or in deficiency—"dwarfs"; and teratology has failed to find adequate explanations of the causes of such variations.

If we may believe the ancient authors, a large number of giants and giantesses attained extraordinary stature, even for persons of that class. Pliny mentions the giant Gabbara, who was nine feet nine inches tall, and two other giants, Poison and Secundilla, who were half a foot taller; Garopius tells of a young giantess who was ten feet high; and Lecat, of a Scotch giant, eleven and a half feet in height. But we may take it for granted that these figures are greatly

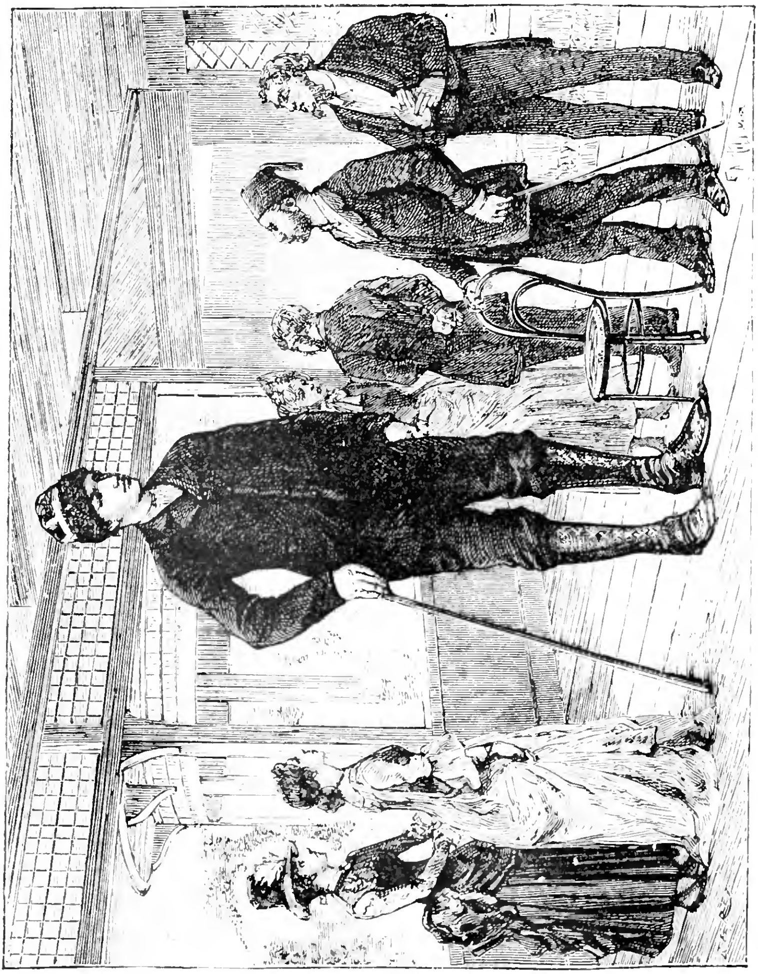


Fig. 1.—Amanab, a Grecian Giant, 2·36 Metres in Height.

exaggerated, while we have a right to regard as authentic giants whose height runs up to eight and a half feet. A giant eight feet high was exhibited at Rouen in 1755. A Swedish peasant, cited by Buffon, was eight feet and eight lines in height, and the stature of the Finnish giant Cujanus was the same ; while Frederick William, King of Prussia, had a guard of nearly equal stature. The giant, Gillé de Trent, in the Tyrol, and one of the guards of the Duke of Brunswick, were more than eight feet four inches in height. The Grecian giant, Amanab, now eighteen years old, is seven feet eight inches tall ; the Chinese giant, Chang, eight feet three inches. The Austrian giant, Winckelmeier, who was recently exhibited in Paris, measuring eight and a half feet, may be regarded as a specimen of the highest stature attained by the human species. At the opposite extremes may be found numerous dwarfs not more than twenty inches, and some even as little as sixteen and even twelve inches in height ; but such dwarfs are only monsters with atrophied limbs or twisted back-bones, or stunted infants, whose age is usually exaggerated by their Barnums. One of the most remarkable dwarfs on record was the celebrated Borulawsky, who was born in 1789, and died in 1837, who was never more than twenty-eight inches in height, was perfect in every limb and proportion, and was bright and intelligent.

The mean between these two extremes of stature is about five feet five and a half inches, and the difference between them is six feet one and a half inch. The mean height is nearly the same with the average stature of Frenchmen. We give an illustration embodying a comparative representation of these extremes, with three intervals between


FIG. 2.—VARIATIONS IN HUMAN STATURE. The giant Winckelmeier, 2·60 metres. A cuirassier, 1·80 m. A man of the average size, 1·66 m. A little soldier, 1·54 m. The dwarf Borulawsky, 0·75 m. A new-born babe, 0·50 m.

them. The portrait of Borulawsky is after a contemporary engraving, that of Winckelmeier from a recent photograph. Beside them are placed a new-born infant of twenty inches, an infantry soldier of minimum stature (five feet one inch), a man of average size (five feet five inches), and a cuirassier of six feet. The illustration comprises all the important variations in human stature.

The conditions that affect the stature of populations and races of men may all be described under one general head—that of nutrition. The size of a population, a race, or a group of individuals living for several generations in the same conditions of environment and resources, is proportionate to its nutrition. Coming to particulars, we find that this nutrition depends, first, on the aptitude for assimilation, which is a question of climate; and, second, upon the facility with which the people can obtain a quantity of food in proportion to their power of assimilation.

It was long believed that climate alone had a great influence on stature; and, in fact, if we regard the white or light-colored races, we remark that the stature is less in climates of extreme temperatures than in temperate latitudes. In the extremely cold Arctic regions, the Lapps, Esquimaux, and Greenlanders are very small; but coming down into more temperate regions and more fertile countries, we find much larger races, like the Norsemen, Russians, Anglo-Saxons, and North-Germans in Europe, and the Canadians and Indians in America. Farther south, and as the temperature becomes hotter, the stature diminishes; a fact which may be verified among the Italians and Spaniards, and which is observed in most of the great regions of the globe.

These variations are not the effect of climate, but are directly dependent, as we have already said, on nutrition. In very cold climates, assimilation is excessive, for the organism needs a large quantity of food to sustain it against the outer temperature. If, in consequence of the rigor of the climate and the limited resources of the country in game and fish, waste is a little superior, or quite equal, to assimilation, the population subject to such conditions must continue small. This is the case with the Laplanders and the Esquimaux of the Arctic islands and the east coast of Greenland. But when game and fish are abundant, the stature of the tribe rises; as takes place with the Esquimaux, whose average height increases as their habitat draws nearer to their southern limit. There the Esquimaux cease to be dwarfs and reach the average height of five and a half feet, or greater than that of the French population. The climate is still rigorous in Canada, and organic assimilation very active, but the country is fertile and food abundant. There the native Indians and the colonists of European origin attain great size and vigor. The Norsemen and the Russians in Europe are in analogous conditions. On what a Russian *mujik* eats in a day a Spanish peasant could subsist for a week. It is to the influence of a keen winter cold and the assimilative power that results from it that the Anglo-Saxon and Germanic races, and the northern and eastern French, owe their size and strength. As the climate grows warm, and the summer heat becomes excessive, nutrition becomes less active and the mean stature of the population decreases: Spain, Portugal, Italy, and Greece are examples of this. The influence of climate upon stature is therefore a question of faculty of assimilation and of the quantity of available food. For this last reason, the fertility of the soil has a considerable influence upon the size of the population. A well-cultivated country, furnishing abundance of food and cattle, permits its population to acquire a much greater size, strength, and robustness than would be possible to a population living on infertile lands insufficiently supporting its inhabitants. By the same influences members of families in easy circumstances, and standing in the position of old proprietors, are usually heartier than poorer families; the inhabitants of towns than those of the surrounding rural districts.

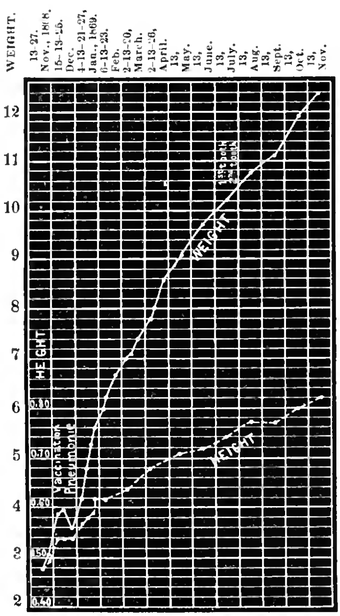



FIG. 3.—CURVE OF THE INCREASE OF HEIGHT AND WEIGHT OF A LITTLE BOY (JEAN LORAIN) DURING HIS FIRST YEAR. (After Dr. Lorain.)

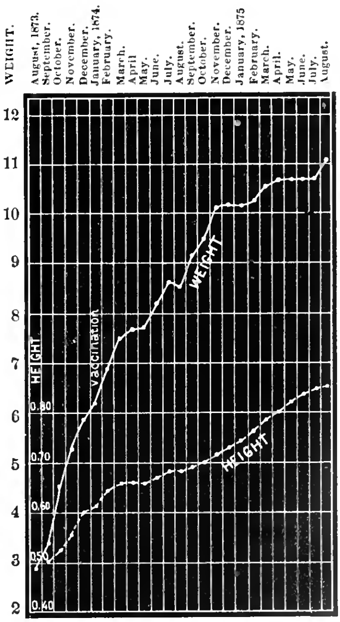



FIG. 4.—CURVE OF THE INCREASE IN HEIGHT AND WEIGHT OF A LITTLE GIRL (JULIETTE R——), DURING HER FIRST TWO YEARS. (After Dr. Lorain.)

(In each of these figures the weight is marked in kilogrammes outside of the diagram, and the rate of growth in height is indicated in fractions of a metre within the first column.)

Famines and frequent or prolonged dearths have the effect of reducing the size of the peoples who are exposed to them. Wars induce the same result, and this not only by the operation of the material disasters and miseries which they occasion, but also through the loss of a large number of the most vigorous and robust men of the nation, and the enfeebling infirmities and sufferings of those who survive. This is what took place in France during the long period of war that prevailed at the close of the eighteenth century and during the first empire.

Among the causes that operate upon the stature of individuals, considered separately, the first place is given to age. The growth of the infant, of the youth, and of the young man till maturity, is not proportional to their ages. It is more rapid in the earliest years, then keeps slackening till the time when the man, having reached maturity, ceases to grow. His stature then remains stationary till the approach of old age, after which it diminishes till the end of life. Some physiologists have tried to determine the law of the mean advance of growth. Buffon has given, month by month for the earliest infancy, afterward year by year, the growth of a young man. Dr. Lorain has represented graphically the variations in the growth in stature and weight of two children; during the first year for one of them, Jean Lorain (Fig. 3), and during the first two years for Juliette R—— (Fig. 4). In these graphics the lower curve corresponds with the stature, and the upper one with the weight; and they enable us to observe the arrest of growth that may have been caused by the sufferings of the child. In Jean Lorain's curve we see the pause that took place when the subject was vaccinated, an arrest which continued, accompanied by a considerable loss of weight, during a period of pneumonia. The occasion of the appearance of the first two teeth also caused an arrest of growth. We can see in like manner on Juliette R——'s curve pauses of growth in both lines, corresponding with indisposition.

Quetelet has represented the mean increase of stature according to age by a curve. The curve has a clearly-defined parabolical form

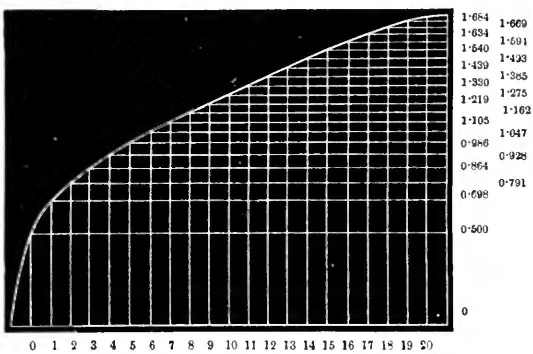



FIG. 5.—PARABOLICAL CURVE, REPRESENTING, BY MILLIMETRES, THE INCREASE IN HEIGHT ACCORDING TO AGE. (From Quetelet's "Anthropometry.")

(Fig. 5). It supposes the child to be fifty centimetres (or twenty inches) at birth. While this curve represents the mean, there are in reality very characteristic differences in the course of growth of children. Independently of the influence of sickness, accidents, excessive mental labors, anxieties about examinations, all causes that have an influence on growth, there are children whose growth is more accentuated than the mean at some period of their existence; and others, tardy ones, who grow till twenty-five or thirty years old, or even longer. With very many youth, growth does not stop at twenty-one years.

The rate of growth of children varies according to sex. Thus, at the age of eleven and twelve years, boys are larger and heavier than girls; but from that age on the evolution of the girls is more rapid, and they soon overtake the boys and pass them, till the age of fifteen years is reached, when the boys regain the ascendency, while the girls remain nearly stationary. A curious relation has been discovered between the growth of children in stature and in weight. M. Malling-Hansen, Director of the Deaf and Dumb Institution at Copenhagen, has for three years weighed and measured his pupils daily; and he has observed that their growth does not take place regularly and progressively, but by stages separated by intervals of rest. Weight also increases by periods after intervals of equilibrium. While the weight is increasing, the stature remains nearly stationary, and *vice versa*. The maximum of increase of stature corresponds with a minimum period of augmentation of weight. The vital forces appear not to work on both sides at once. These variations are subject to the influence of the seasons. During autumn and early winter, according to M. Malling-Hansen, the child accumulates weight, while his stature increases slowly; but during spring, stature receives a veritable push, while weight increases but little. Some local habits have an influence on the stature. Stendhal remarked that many Roman girls had deformed vertebral columns, or were a little humpbacked, and found that it was the result of a popular belief prevailing in Rome that parents could promote the growth of their children by punching them in the back! A popular custom in some of the towns of Switzerland also affects the development of the children. Mothers are accustomed to give them brandied lumps of sugar to keep them from crying. It has been learned from experiments on animals that alcohol tends to stunt the growth of the young. The habit of some women of the lower classes of drinking brandy during pregnancy in order to give their children fair complexions must likewise have a bad influence on the development of the children. On the other hand, growth is favored by strong food, rich in nitrogen and phosphates, by good hygiene, by play and gymnastic exercises, by plenty of air, and by all the causes that contribute to make children strong and vigorous.

One of the less recognized agencies affecting stature is fatigue, under the influence of which the height diminishes. A soldier, for instance, is perceptibly taller before than after a forced march; when the body is fatigued it gives way, the cartilages lose their elasticity and become thinner, and the fatty and fibrous cushions, which give spring to the organs of locomotion, become less supple and more attenuated, all of which contribute to the diminution of height. Carrying burdens on the head or shoulders leads to the same results. If to an excessive fatigue is added privation of sleep, organic reparation can not take place, and the causes which contribute to the diminution of stature accumulate and effect in the total a decrease which is relatively considerable. This fact is known to the tricksters who practice upon young men liable to military service so as to secure exemptions for them. If the men are only a few centimetres over the minimum standard of the service, these practitioners put them through a variety of fatiguing exercises, with carrying of burdens and privations, etc., till they succeed in reducing them below the minimum and causing them to be rejected on examination. The same influence of fatigue is also felt in ordinary life. The simple standing position, walking, and riding, all contribute to a reduction of the height. We are all taller in the morning than in the evening. Professor Martel made a communication on this subject to the German Surgical Congress held in Berlin in 1881, and presented a number of measurements, from which he concluded that men's statures varied perceptibly according to the hour of the day. The variation differs according to occupations, being less in the case of those which are sedentary.

The height of the adult continues stationary during mature age, but begins to diminish at about fifty-five or sixty years. The decrease is independent of the curvature of the vertebral column, and is exhibited upon robust men who still hold themselves up straight. It depends upon several causes, among which are a modification of the neck of the femur, flattening of the fatty cushions, with gradual ossification and decrease in thickness of the cartilages of the joints, particularly of those of the vertebral column.

Physical aptitudes are various according to stature; and we are able to draw important conclusions, particularly with reference to fitness for military service, from the determination of them. The bodily vivacity of small men is very much greater than that of large men. The man of small stature is nearly always quicker and more alert than a man who is tall and stout in proportion. This should be evident, for such a man has less weight to displace when he is moving, jumping, or climbing; while it has been proved, by many experiments on animals, that the strength does not increase in proportion to the weight. Two horses weighing together three quarters of a ton can perform much more work, particularly if it be work involving rapidity, than a single horse having the same weight. A similar difference exists in the power of one large and stout man and two small men. The ratio of muscular energy to the pound of living weight is much greater with small or middling-sized men than with very large ones. The length of the limbs of the latter necessarily occasions an amplitude in his motions that makes execution slower. Length of limbs also contributes to a waste of strength. We can compare the arm, for instance, with a lever, the fulcrum of which is at the shoulder-joint, the point of action at the hand, and the power in the muscles. It is evident that the larger the arm of this lever is, the more energetic will the muscular effort have to be. The large man's power of endurance is less than that of the middling-sized man, because not only of the personal weight that has to be carried, but also on account of the difference in the proportional development of the respiratory system. The power of endurance may be estimated in a man at rest by taking the proportion between the height and the circumference of the breast at the height of the mammary processes. The larger the proportion of the latter element, the greater will be the power to resist fatigue. The French marine formerly accepted only those men whose breast-measurement was at least half their height. The same degree of development is required in Switzerland, and the acceptance of young men who can not display it is adjourned from year to year. Thus, looking at military aptitudes, it is middling-sized or small men that offer the greatest energy, power to resist fatigue, and activity in battle; and of this kind is the popular type of the French soldier—the *petit chasseur*, or the soldier of the line.—*Translated for the Popular Science Monthly from La Nature.*

## THE PANAMA CANAL.

By STUART F. WELD.

NOT a little skepticism, and even some hostility, have existed among us as to the Panama Canal; and, perhaps, any other nation in our situation would have entertained similar sentiments. It is worthy of note, however, that the nation was not lacking in tact when it refrained from showing any such feelings during the recent visit of M. de Lesseps. De Lesseps was the guest of the United States; and it is hardly civil to criticise one's guests. He was here not as a representative of the Panama Company, but as President of the Franco-American Union. Upon the death of the first president, Edouard Laboulaye, he had been elected to this position. This Union had collected the funds destined to carry out the design of Bartholdi, and it naturally devolved upon its head to make the presentation speech on the 28th of October, the day of the inauguration of the statue. The Panama Canal had no connection with the Statue of Liberty; but every one thought of De Lesseps as the constructor of one interoceanic canal and the projector of another. It was natural, therefore, that something should be said, after all, about the Panama enterprise. A banquet was offered to De Lesseps by Cyrus W. Field, October 27th, the day before the ceremony upon Bedlow's Island. On the 2d of November, one was tendered him in like manner in Philadelphia by

George W. Childs. On the former occasion, Mr. Field, having referred to the Suez Canal and the obstacles met with in its construction, said with regard to De Lesseps and Panama: "As that work is now in progress, it may be presumptuous to speak of what is in the future. I can only say that I learned in Egypt that it will not do to say that anything is impossible to M. de Lesseps, and that he has with him the ardent hopes of all Americans that he may not taste of death till he has carried out his last and greatest work, which will link his name imperishably with this New World as it is already linked with the Old."

Sentiments of this sort, in sympathy with the undertaking rather than opposed to it, were expressed at the banquet in Philadelphia. De Lesseps, in the course of his visit, listened rather to what admirers or sympathizers had to say than to utterances of another description. But these compliments are not a reflection of the whole of public sentiment. Many Americans, having assumed in the beginning an antagonistic feeling toward the enterprise, are still disposed to keep that feeling and to support it by regarding largely if not chiefly the difficulties to be met. It may not be out of place to see how far this attitude is justified by the physical elements of the vast undertaking and the financial prospects of the Panama Company; we may also glance at facts, perhaps at the opinions of authorities, as to the desirability of some sort of interoceanic passage.

In 1883 Admiral Cooper, then in command of the United States naval forces at Panama, submitted to the Navy Department a report upon the condition of the enterprise; in this he says: "The whole undertaking is so gigantic that one can not believe that it will soon be finished; but I am impressed with the fact that the French are thoroughly in earnest, and that if they fail to finish the canal on account of want of funds the work done by them will be well done, and will be so extensive as to always give this route great advantages over any other." He also observes: "Opinions have been expressed that the work is being delayed by unnecessary attention to details and in making provision for possible emergencies; but this careful preparation for the great undertaking strengthens my belief that the canal will ultimately be finished more than anything else."

These opinions were expressed some four years ago, when hardly a beginning had been made in the matter of excavation, less than one million cubic metres having been removed. The amount removed up to the 1st of January of the present year was thirty millions, about a quarter of the whole.* It is safe to say that since 1883 the chances

* This estimate, twenty-five per cent, implies the completion of the work as a sea-level canal. As much as this, however, we ought not to assume. Should the work be completed as a lock-canal the requisite excavation would be much less.

With regard to the total excavation, estimated by the company at 120,000,000 cubic metres, authorities are not agreed. Lieutenant Kimball, United States Navy, from whose of the completion of the work have improved. Yet it is not to be assumed that De Lesseps and the present company will be able to complete it. Only recently they failed to get the authorization of the French Government to raise 600,000,000 francs by means of a loan

late report to our Government one or two extracts are to be taken, speaks doubtfully upon this point, but seems to think it likely that the excavation will reach 135,000,000, or perhaps more. He observes that the slopes adopted by the company are two to three in soft earth (two of vertical dimension to three of horizontal) and two to one in rock; these he thinks not sufficiently gradual, and hence his larger estimate.

With regard to the amount excavated, January 1, 1887, 30,000,000 cubic metres, it may be added that, according to two authorities favorable to the enterprise, Hon. John Bigelow and M. de Molinari, who inspected the works last year with De Lesseps, a somewhat lower figure may be assigned. They give as the amount excavated at the time of their inspection in February, 1886, 14,000,000 cubic metres instead of 19,000,000, the figure of the company. De Molinari, however, remarks that these 14,000,000 cubic metres do not include the whole excavation. This he puts at 17,000,000, only 2,000,000 below the company's reckoning. He explains that the 3,000,000 excluded refer to accessories—the excavation of roads over which to carry the extracted material, etc. Such parts of the excavation, he seems to have thought not comprised in the estimate of 120,000,000 cubic metres. His carefully-prepared letters, published in the "Débats," and which relate both to the Panama enterprise and to the economic condition of several of the West Indies, have recently appeared in book-form. The author, well known as a writer upon political economy, dedicates his work to De Lesseps.

Finally, it may be remarked that the entire excavation for 1886 reached 11,727,000 cubic metres, an average of almost 1,000,000 per month. The excavation for the first three months of the present year is as follows:

| | | |
|---|---|---|
| January | 1,051,000 | cubic metres. |
| February | 1,286,000 | " |
| March | 1,100,000 | " |

The decrease in the excavation for March is for the most part only apparent; for, as the work is reckoned from the 25th of each month to the 25th of the next, March thus gets twenty-eight days while February gets thirty-one. It is safe to conclude that the excavation for 1887 will equal, and probably exceed, that for 1886. At the lowest estimate the amount removed up to July 1st may be set down at 36,000,000 to 37,000,000 cubic metres; an amount which may be the more readily assumed since the work usually progresses more rapidly during the first six months of the year, the dry season, than during the wet season which succeeds. The excavation for February, 1,286,-000, is seventeen per cent higher than that for any other month since the work began.

The following table, taken with the exception of the figure for 1886 from De Lesseps's last annual report, gives the average monthly excavation each year:

| | | |
|---|---|---|
| 1882 | 16,245 | cubic metres. |
| 1883 | 215,300 | " |
| 1884 | 617,054 | " |
| 1885 | 658,708 | " |
| 1886 | 977,250 | " |

Possibly 1887 is to show a considerable increase over 1886, as 1886 did over 1885. We should remember that, owing chiefly to the improvements effected in the machinery used at Suez, more excavation was effected during the last three years than during the previous seven. If we could allow ourselves to make such a calculation for Panama, the work might be finished in 1890. Mr. Bigelow is of opinion that upon this contingency, the progress of invention, De Lesseps counts at the present day; and, in fact, the work at Panama has already been accelerated in this manner.

with lottery drawings attached. It was by just this method—a lottery loan—that the Suez Canal was finished, but the French legislators of 1886 hardly took the degree of interest in the Panama scheme which those of 1868 did in the Suez. Only eight votes were cast against the bill of 1868, and this enactment carried the work through to its completion.* The result in the present case has been that De Lesseps was obliged to go upon the market and raise about one third —200,000,000 francs—the amount asked for, upon comparatively onerous terms. This sum, added to 75,000,000 francs, the last quarter of the stock capital, called in in September, will enable him to continue the work for one or two years. It remains to be seen whether, prior to the expenditure of these sums, a renewed application to the French Government will meet with better success. It should be remembered, after all, that the French Government favored the application of the company. It introduced a bill based in its essential features upon the bill of 1868. Opposition existed not in the ministry but in the Chamber, and it is possible, to say the least, that upon a subsequent occasion the ministry and Chamber may find themselves in accord.

It may, perhaps, be considered doubtful whether the present company is to complete the work, and whether the French are to maintain the financial control they at present possess. But it can not be denied that powerful incentives must influence the French Government and the French people toward the support of the company, and the keeping of the work in De Lesseps's hands. In no way can the weight of such considerations be shown better than by the following extract from the late report of Rousseau, the commissioner of the French Government. He inspected the work in February, 1886, and at the close of his report says:

"In fine, I consider the cutting of the Isthmus of Panama a possible work, and that at present it has been carried so far that it can not be abandoned. . . .

"Such an abandonment," he goes on, "would be in fact a veritable disaster, not only for the stockholders, who are nearly all French, but as regards French influence all through America. . . .

"It does not seem to admit of doubt that, if the affair failed in the hands of the French company, it would be immediately taken up by a foreign company to prevent the fruits being lost of the enormous sacrifices made and the results obtained. . . .

* It is true that the amount of the loan asked for in 1886, 600,000,000 francs—the calculation of the company being that 600,000,000 added to the 600,000,000 already spent or still disposable would complete the work—much exceeds the loan obtained for Suez, 100,000,000 francs. But we may remember that the commerce and wealth of the world have vastly increased available capital; and, moreover, the astonishing financial success of the Suez Canal ought to serve as a powerful stimulus. According to the estimate of the Paris Congress, Panama was to cost double what Suez did. But the commerce of the world will have more than doubled, reckoning from 1869, before the work at Panama is completed.

"The Panama Company, because of the names and past of the men who direct it; the eminent advisers whom it possesses; the grand and in some sort humanitarian character of the work it pursues; because of the serious efforts which it has already made, and is still making successfully to complete the work, deserves in a special sense the regard of the Government."

Much has been said as to the unfavorable character of the report of Rousseau. Although not published in full, it is understood not to be in every respect what De Lesseps would have wished. Yet, judging from the passages quoted, it is plain that the author is in no sense indifferent to the fate of the undertaking. He recognizes the stake possessed in it, alike by the French people and the French Government.

It seems, therefore, probable that the French will make strenuous efforts to finish the canal; reports, on the other hand, have been current as to the calculations of English, German, and American capitalists, in view of a possible collapse. A year or two will probably determine the success or failure of the company. It has, however, a resource wholly within itself—the reduction of the cost by making the canal with locks instead of cutting it to the sea-level. This is the course recommended by the commissioner of the French Government, Rousseau. Upon such conditions the assistance of the Government might be more readily obtained than if the company should persist in endeavoring to carry out its original purpose. In case the lock solution should be adopted, it is to be kept in mind that such a canal at Panama possesses one unquestioned advantage over one at Nicaragua: the former can, while the latter can not, be converted into a sea-level canal.

It may be observed, besides, that the only plan for a canal at Panama ever submitted by the engineers of the United States, that of Lull and Menocal, in 1875, is a plan including locks. De Lesseps is not a man to neglect his own interests; he might be ready enough, no doubt, to take a hint, never mind from what source. *Fas est ab hoste doceri.** Should this design be adopted, so as to get the canal through, and should the undertaking prove remunerative, capital might be subsequently raised to deepen the work to the sea-level.

One common error in estimating the cost of the canal here deserves attention. The preparatory expenses of such an undertaking are large. A heavy outlay is required before much more than a beginning can be made in the matter of excavation. The Hon. John Bigelow, in his report upon the status of the enterprise, submitted to the New York Chamber of Commerce in April, 1886, gives a table of the expenses down to July, 1885. It is taken from De Lesseps's annual report of that date. In it the expenditure up to this point is put down at 368,-

* This is not a point to be pressed. Wyse and Reclus prepared two plans for a ship-canal at Panama, one a sea-level plan and one with locks. The former was adopted by the Paris Congress. It was plain, however, that should this method of execution prove too expensive, the company might fall back upon the other alternative.

000,000 francs, while the amount set down under the heading, "clearing the surface of wood and stumps, installing machinery, and excavation," amounts to but 115,000,000 francs. This is less than a third of the whole. Mr. Bigelow observes that this "last item only, and that partially, represents work on the canal." He assumes that this 115,000,000 francs represents the cost of about one fifth of the excavation. Now, it has been customary for the critics of the undertaking to argue thus: If one fifth of the excavation costs 368,000,000 francs, it is easy to see that the whole will cost about 1,800,000,000 francs, a sum greatly in excess of the estimate of the Paris Congress. This estimate was 1,070,000,000 francs.* But the above method of computation is obviously erroneous. Mr. Bigelow, referring to it, says: "It would be very misleading to infer the cost of the work remaining to be done from the apparent cost of what has been done. Fully two thirds of the expenses already incurred are in the form of plant." He points out in like manner that it would be "scarcely more fallacious" to infer that because one fifth of the excavation had been made for 115,000,000 francs, the money required to complete it would be only four times that amount. The work which remains is much more difficult than what has already been done. As the trench descends to lower and lower levels, it becomes more expensive to get rid of the material excavated.

Another criticism of a somewhat vague and yet serious character is brought against the undertaking. It is said that lavish expenditures, a reckless disregard of prudence and economy, have characterized the work. Upon this point also Mr. Bigelow's testimony is not without weight. He says: "No doubt some of the money has been injudiciously expended, but what great work, whether of a private or public character, has escaped this reproach? Taking the waste through these channels at the largest presumable figures, the inconsiderate expenses of the average individual all over the world would probably represent a larger percentage of his aggregate expenditure." †

* It is not to be inferred that even so large a sum as 1,800,000,000 would preclude all chance of reasonable profits. A statement upon this point was made at the Geographical Congress of Hamburg, held in April, 1885. One session was devoted to a lecture upon the Panama Canal, given by a Dutch engineer, Van Nehus. He said: "According to the learned report of the French economist, Levasseur, the probable annual tonnage of the canal would be 7,250,000, and this at the rate of fifteen francs per ton, after deducting 3,000,000 francs for maintenance, would afford an income of 105,750,000 francs. This would give a satisfactory interest, even for a stock capital of 2,000,000,000 francs."

† "The Popular Science Monthly" for April, 1880, in an editorial discussion of the canal question, makes the following observation. The editor, referring to the fact that the foreign holders of American securities have been not unfrequently, by skillful manipulators defrauded of their just dues, says that De Lesseps "defies the world to show that a centime of the funds contributed to the Suez Canal was misappropriated or stolen."

Of the contrast which, according to the opinion of some, exists between the financial management of Suez and that of Panama no sufficient evidence seems to exist.

Before leaving Mr. Bigelow's exposition of errors, into which unless upon our guard we might perhaps be led, it may be observed that his report, prepared after a personal inspection of the work, is one of the most judicial documents published upon the subject; and those desirous of forming an impartial estimate would do well to acquaint themselves with it. To indicate the importance attached by Mr. Bigelow to the completion of the work we may cite the passage which follows. He observes that the French, especially people of moderate means, possess for several reasons extraordinary faith in De Lesseps; partly because they know that De Lesseps does not "job" with the securities of the undertaking; partly because of the financial success of the Suez Canal; and partly because the completion of the Panama Canal under De Lesseps's auspices "would rank among the half-dozen largest contributions ever made to the permanent glory of France."

These references to Mr. Bigelow's report may be supplemented by an extract or so from the latest report made to our Government on the subject, the "Special Intelligence Report" of Lieutenant W. W. Kimball, United States Navy, who inspected the works about the same time as Mr. Bigelow, early in 1886.* Lieutenant Kimball says: "That with a sufficient expenditure of money, time, brains, energy, and human life, the canal can be finished, is self-evident, but it would be idle for me to attempt to estimate the necessary quantity of all or any of them. Too many of the prime data for calculation are unknown quantities."

If such a statement on the part of Lieutenant Kimball makes us cautious in accepting the present, or at least recent, estimate of the company as to ultimate cost, 1,200,000,000 francs, it may make us equally cautious in accepting the pessimistic, larger estimates which appear from time to time.

As regards the plans Lieutenant Kimball says, "As might be expected of the work of the eminent engineers who have made the plans, the design is almost above criticism."

With reference to the proposed dam at Gamboa, by which the freshets of the Chagres River are to be controlled, a work as to whose impracticability or insufficiency much has been said, the writer observes, "The engineering difficulties are to me not at all patent."

This exhaustive report is not without strictures upon the course of the company in certain cases. Lieutenant Kimball, in particular, is disposed to think, while holding that the plans for the control of the Chagres River are practicable enough, that their execution has been unadvisedly delayed; floods have at certain points carried into the excavation fresh deposits which will require to be re-excavated.†

* The writer is indebted to Lieutenant Kimball for permission to make use of the proofs of his report.

† Since the above was written, a dispatch from Washington states that an inspection of the canal was made in March by another officer of our navy, Lieutenant C. C. Rogers.

In concluding these considerations, it may be remarked that it is less than ever safe to try to fix at present the cost of the undertaking. The company is considering the advisability of executing it upon a less extensive and costly scale in certain respects. Possibly, though the company has for the present decided against it, the lock plan may be adopted, and, until such practical questions are finally settled it is impossible to estimate the expense.

Some may still ask, Is a canal or a ship-railway worth building, after all? Even Admiral Ammen intimated doubts as late as 1879, after the decision of the Paris Congress, as to whether the time had come to cut the Isthmus.* It may not be hard to satisfy ourselves on this point. In a report submitted to the Navy Department in 1866 by Admiral C. H. Davis, an estimate is given of the tonnage which would have used a canal had one been in existence, as well as of the loss inflicted upon commerce because of its lack.† The former estimate is 3,094,070 tons, which agrees pretty well with the estimate of the Paris Congress for the year 1879, if we assume the rate of annual increase from 1866 to 1879 which the Congress adopted. Admiral Davis's estimate of the loss annually experienced by commerce was $49,530,208. These estimates, made over twenty years ago, would be evidently too low for 1887. But even should we assume that in the course of the past twenty years no increase of traffic had occurred, a result sufficiently surprising would be arrived at. The loss to commerce in four years would amount to $200,000,000, about the cost of the Panama Canal according to the estimate of the Paris Congress. This simple calculation shows the importance of the work. Mr. Bigelow, in his report, already quoted, says, with reference to the Panama Canal, "Were all nations to contribute toward its construction in any equitable proportion to the advantages they would derive from it, the stock would be as difficult to obtain as the golden apples of Atalanta."

We have thus far supposed that the tonnage which would pay dues to a canal, as well as the loss which the lack of a canal occasions, has not increased for the past twenty years. It is true that Admiral Davis's computation of this increase would lead us to exaggerated conclusions. According to this estimate, the tonnage which would use a canal would double every ten years. The estimated loss ex-

According to this dispatch, Lieutenant Rogers states in his report that the company did as much work during the past year as it had done in all the preceding years—which seems to be an exaggeration. While he doubts somewhat that the present company will be able to complete the undertaking, he thinks the ultimate completion of it is certain, and he considers it better to finish the Panama Canal than to spend money on the Nicaragua project.

* "The American Interoceanic Ship-Canal Question," by Admiral Ammen, p. 66.

† These computations, as well as an estimate of the supposed rate of tonnage increase, were originally made by Frederick M. Kelley and published in a pamphlet in 1859. They are incorporated by Admiral Davis into his report.

perienced by commerce being for 1866, $50,000,000, would be for 1876, $100,000,000; and for 1886, $200,000,000. According to this computation, the annual loss to commerce at present is equivalent to the cost of the Panama Canal as estimated by the Paris Congress. Every year, if we may assume the above data, money enough is wasted because we do not have a canal to build one! Such a calculation is, however, in excess of the truth. The computation of Levasseur, the one adopted by the Paris Congress, that sixteen years would be required to double the tonnage, is more moderate and much more reliable. According to this, if the loss in 1866 may be set down at $50,000,000, the loss in 1882 would be $100,000,000. It is quite possible that the truth lies between the estimates of Levasseur and Davis. Over a page of Mr. Bigelow's report is devoted to the estimates of a commercial journal of Paris, The "Revue-Gazette," and these exceed the estimates of Levasseur. Authorities differ but even estimates not among the highest show that some interoceanic route for ships is one of the greatest commercial needs of our times.

It seems almost superfluous to ask for the indorsement of names to an enterprise of such great utility; but, as the testimony of experts has weight with many minds, a few authorities of unquestioned competence may be cited. Among such may be reckoned Admiral Ammen. Appointed by General Grant one of a commission of three to report upon the interoceanic question, he was subsequently sent by our Government to represent it at the Congress of Paris. In his volume upon the interoceanic question, he observes that the result to be attained is "the grandest that man is capable of achieving for the amelioration of the commerce of the world." *

Not less significant is the opinion of the late W. W. Evans, an American engineer of distinction. Of Mr. Evans, Admiral Ammen remarks, in a recent publication, that his name is known all over the world. Mr. Evans wrote in 1879 that this canal matter was "the most important matter in the line of progress now before the world." † Such a statement may perhaps lead us to ask, Does not the ascription to the canal of such a preponderant influence connect itself with questions of international law? Admiral Davis, in his report, already cited, quotes from a writer, whose name he does not give, this statement, viz., that the cutting of the Isthmus would prove "the mightiest event probably in favor of the peaceful intercourse of nations which the physical circumstances of the globe present." Assuming that it is desirable that the peaceful intercourse of nations be promoted, another question naturally presents itself: Would it be promoted or not by the establishment and recognition in the cases of Suez and Panama of the neutrality of these works? This is not an occasion to discuss such a

* "The American Interoceanic Ship-Canal Question," by Admiral Ammen, p. 67.

† "Journal of the American Geographical Society for 1879," p. 144.

point. It may be enough to indicate the significance which attaches to it.

Among other authorities may be named Admiral Davis, Professor Nourse, United States Navy, who prepared for the department in 1883 a report upon the Suez and Panama Canals, Lieutenant Maury, General Grant, and Senator Windom. In the Senate, February 28, 1881, the latter observed, after referring to the significance of the work and the demand for its execution, that it was a wonder it had not been sooner undertaken. Pitt, Jefferson, and Humboldt, are men of a former generation who interested themselves in the problem.

As the work is at present in French hands, some reference to French authorities might not be out of place. The curious may consult to advantage an address delivered by Renan, April 23, 1885, when De Lesseps was received by the French Academy. Renan, after assuming that the possible inhabitants of the planets may have better telescopes than ours, alleges that they might judge of our civilization by the state of our isthmuses. "A planet," he continues, "is not ripe for progress till all its inhabited parts are brought into intimate relations, each with each, so as to constitute a living organism, so that no part may be able to enjoy, or suffer, or act, without feeling and reaction in all the rest."

Nor is it to be said that this reference to the cutting of isthmuses as a touch-stone of civilization is an empty compliment, one which might fitly, perhaps, find its place in a eulogistic address. The testimonies adduced as to the division of the American Continent are explicit enough. It is safe to say that if the completion of any enterprise in course of execution to-day is loudly called for by the interests, even the necessities of *all* states, it is the enterprise at Panama. The French may not be able to complete it—if by them it is to be completed—as soon as their wishes and certain possible political calculations have designated. They may not celebrate its inauguration, and at the same time celebrate the centennial of the Bastile and the era of the Revolution. Let us hope, at all events, that the inauguration is not to be long deferred.

The proper spirit in which this great enterprise ought to be regarded is perhaps set forth in the following lines from a German source. The Gazette of the Administration of the Railroads of Germany, published in Berlin, expressed itself in a recent number thus:

"In conclusion, we should not fail to express a hope that the courageous builders of the canal will succeed in overcoming all obstacles, so that a great work, which will be the pride of the engineering art of to-day, and even of the nineteenth century, may be successfully finished by those who thus far have borne the entire labor and the entire weight. If the present company should fail, certainly a second would be formed which would inherit the advantages and experiences of the first, without having paid for these at its own risk and by its own work. The undertaking is chiefly in French hands, and we Germans have but little interest to favor the extension of French glory and success; but the divergencies which exist between nations should disappear in face of the great spirit of enterprise, which animates the director of the canal, M. de Lesseps, and in face of the private capital invested, which, though it be invested to promote private interests, has a general interest as well." *

Of such views it is safe to say that they are at least deserving of consideration. They are much to the credit of the writer, whose breadth of view and liberality of judgment alone enabled him to pen them.

## THE NORTH AMERICAN LAKES.

By ISAAC KINLEY.

IN America, as in the Eastern Continent, the North is the land of lakes. A line from the mouth of the St. Lawrence to the western end of Lake Erie, and thence to the mouth of the Mackenzie, lies through and near a succession of lakes unequaled in number and aggregate area by any other like extent on the earth. The great North American depression, extending northward from the Gulf of Mexico, bifurcates at about the fortieth parallel, one branch trending northeastwardly to the Atlantic Ocean, and the other northwestwardly to the Arctic, lying nearly at right angles to each other, and in approximate parallelism to the mountain-ranges and shore-lines of the continent.

The forty-second parallel holds, to the north of it, nearly all the North American lakes, while to the south are numerous lake-basins, some of them rivaling even Superior in extent. These have been drained of their waters by the deepening channels of their effluent streams; or, as in the arid regions of the Southwest, by evaporation.

If we define a lake as, what geologically it actually is, *a local depression of the surface*, and treat the pressure or absence of water as only one of its accidents, we shall find the South, no less than the North, to be a land of lakes.

Lake-basins may be due—

1. To local sinkings of the surface.
2. To excavations, notably by glaciers.
3. To the extinction of volcanoes, their craters filling with water.
4. To the breaking down of cave-roofs by earthquakes or other causes.

To the first and second of these agents are probably due nearly all the existing North American lakes, in some the one and in some the

* "Bulletin du Canal Interocéanique," December 1, 1886.

other acting as principal. In all the larger lakes there has evidently been a local sinking of the surface, the glacier having been only auxiliary. The numerous small lakes in Middle and Western New York lying in the direction of the glacier-flow, and having frequent groovings on their adjacent walls, have been credited wholly to the glacier. But, as nearly the whole of this lake-region lies within the Niagara limestone formation, it is not improbable that the falling of cave-roofs may have greatly aided the work of the ice-plow. Many small lakes and ponds, as in Kentucky, Tennessee, and Southern Indiana, are due wholly to the falling down of cave-roofs. In South-Eastern Missouri and Eastern Arkansas are lakes and lakelets where these roofs were shaken down by the earthquake of 1811. Lakes Borgne and Pontchartrain have been captured from the Gulf by the delta of the Mississippi; while numerous small lakes, called bayous, have been formed by changes in the river-bed, the deposit of sediment at both their inlets and outlets having kept them filled with water. Crater-lakes are not infrequent. These basins, but containing no water, abound in New Mexico, Arizona, and Southern California, while many of the beautiful lakes of the Italian Peninsula are but the filled craters of extinct volcanoes.

Why is the North the land of lakes? In order intelligently to answer this question, let us see what has been going on at the South. Between the Alleghanies and the Blue Ridge is a long, narrow valley extending nearly the whole length of these parallel ranges; and, but for the breaks in whose walls, the whole extent must have been a basin of water. At Harper's Ferry, the Potomac, and near the Natural Bridge, the James River, have broken through the Blue Ridge carrying the waters of the upper half of the valley to the Atlantic. Farther to the south the Kanawha and the Tennessee drain the lower half into the tributaries of the Gulf of Mexico. These last-named rivers have also broken through the Cumberland Mountains, draining another considerable valley between these and the Alleghanies. Could these several outlets be closed, as they probably once were, large lakes would again rapidly form, and the work of abrasion and drainage begin anew. Could the Knobs and the Muldro Hills unite again at the falls of the Ohio, a large shallow lake would form, covering parts of Ohio, Indiana, and some of the fairest portions of Kentucky. Should the bluffs of the Wabash come together at the mouth of the Salimony, another shallow lake would result, whose outlet would probably be the Maumee. Commencing at Richmond, Indiana, itself situated in a small lake-basin, and thence northeastwardly half-way across Ohio, is a succession of shallow depressions once filled with water, and through which still flow the streams whose unceasing work has cut through their margins and emptied them of their contents. In many of these ancient lake-basins the draining is not yet completed, the lowest parts being still marshes or ponds of water. The Mohawk and the Connecticut flow each through a bead-roll of small lake-basins, walled around by solid rock. Through their margins the rivers for untold ages have been deepening their channels until the lake-bottoms have become dry land, and the homes of men. The Great Lakes themselves have, from a like cause, been much reduced from their former dimensions. The evidences are abundant that Lakes Michigan, Erie, and Huron are but the relics of what was once a large body of water, covering all the intervening and much of the adjacent lands. The work of depletion is still going on. Not only is Niagara deepening its channel and sinking thereby the surface of Lake Erie, but by the gradual recession of the falls a much greater work is prophesied. It is only a question of time when Erie will be robbed of its waters, and the other Great Lakes reduced to insignificant parts of their present dimensions. Lake Pepin, now but an expansion of the Mississippi, was once a much larger body; and Peoria, a similar widening of the Illinois, once spread over the adjacent level lands equaling in area that of Lake Champlain.

Doubtless, in many of these lake-outlets, natural fractures and marginal depressions have not only given direction to the effluent streams, but greatly aided in the work of abrasion. The evidence, however, of the former greater extent of these lakes is abundant and apparent. The railroad from Lafayette, Indiana, northward cuts through several low lake-margins, marking the gradual retreat of the waters; and runs within sight of several sand-hills similar to those on the lake-shore near Michigan City. There are evidences that the Illinois was once the outlet of Lake Michigan and the Wabash that of Erie, carrying the waters of these lakes to the Gulf of Mexico.

It is now generally conceded that the whole northern part of the continent, reaching southward in some places to the thirty-eighth parallel, once wore an ice-cap of immense thickness, through which only the mountain-peaks projected. I have already alluded to the work of the ice-plow in the excavation of lake-basins. I am now about to give to the glacier the credit of their preservation when formed.

Although it has been found that the glacier flows like the water of a river, only more slowly, the ice, except when wedged in between two walls, as the Mer de Glace, could not have been confined in narrow channels, and can not, therefore, have grooved out long, tortuous river-beds. The abrasion and drainage were indeed going on, but by a slow process, as compared to the work of the released and active waters.

When the ice-field began to disappear it gradually receded northward, first uncovering that part of the drift-region in which the lakes have been wholly drained. The southern half of the continent has had even larger rivers than now fed by the ice and snow of the gradually disappearing glacier. The length of time during which these rivers were doing their work of excavation, while the North was still wearing its ice-crown, can be only approximately guessed. It was, however, a long time—a time compared with which the historic period dwindles into a few days. During these long ages, the outlets of the more southern lakes were being sunken by the slow disintegration of the rock; and, doubtless, while the ice-king still reigned in the North, these now "sweet vales of Avoca" had become dry land, and possibly the homes of men.

The physical geography of the country is a strong witness to the truth of this hypothesis. To the south of the drift, where the rivers have been flowing ever since the continent was above the sea, the lake-bowls have been drained to their bottoms; in the southern part of the drift they have been only partially drained, while to the north they are still filled with water. This exactly accords with the hypothesis.

It has been argued that the southern half of the continent has been longer from under the sea, and therefore that the rivers have had more time for deepening their channels. Exactly the converse is the truth. The Laurentian Hills are not only the oldest land on the continent, but, so far as now known, the oldest on the planet.

It may be admitted, without affecting this hypothesis, except it be to re-enforce it, that the great weight of the accumulated ice must have sunk the more northern region in some parts below the sea-level, and that in its gradual melting these rose again, preserving their equilibrium.

The gradual recession of the ice northward, and therefore the first uncovering of the southern half of the drift-region, must have taken place. That this recession was slow, and during a long period of years, must be true. That during this long time the rivers must have been deepening their channels and emptying the lake-basins, is so manifest as to need only to be stated. It we should term that portion of the drift-region, south of forty-one and a half degrees, *sub-glacial*, we shall find the southern part of it wholly drained, the middle and northern part of it only partially so, the lakes and lakelets increasing in number and magnitude on approaching its northern boundary.

But the "dry lakes" of the Pacific slope, what of them? Their margins are still intact. True; but it is because they *are* dry lakes that their margins have not been cut through and no rivers connect them with the sea. These lake-basins, too, were once filled with water; the rain-supply was not equal to the evaporation, and hence their gradual drying up.

Another cause for the destruction of lakes, too important to be left out of the account, is the continuous deposit of sediment on their bottoms. While their effluents are continuously sinking their surfaces, their affluents are no less industriously raising their bottoms by deposits from the land. The bottom of Lake Superior at its deepest place is about three hundred feet below the sea-level; it can not, therefore, be wholly drained by its outlet. But its supplying streams are constantly sifting sediment on its bottom. The St. Louis River has a large delta, making access to Superior City so difficult as to require annual dredging. It has been estimated that the sediment yearly carried to the Gulf by the Mississippi is sufficient to raise a square mile two hundred and forty-one feet, or equaling a cubic mile in a little less than twenty-two years. Where the Rhône enters Lake Geneva, its water is loaded to its capacity with sediment; where it leaves the lake, it is crystal clear. This solid matter is being continuously deposited, raising the bottom, while the deepening channel is sinking the surface. In Indiana and Ohio are numerous shallow lake-basins, now dry land, their bottoms, level as a floor, with often several feet of rich alluvium, still bearing testimony to the agencies that have despoiled them of their waters. The celebrated Walnut Level of the former State is but an ancient lake-basin, and it is to this deposit of sediment that it owes its far-famed fertility. It is not improbable that by the time the Falls of Niagara shall have broken through the rim of Lake Superior, the sinking surface of the water may reach the rising bottom only a little above the ocean-level.

But why should the lakes begin to increase in size and frequency at about the forty-first parallel? The answer is to be found in the relative amount of snowfall during the glacial epoch. More snow falls at the south end of Hudson Bay than at Boothia Felix; more at Cape Farewell than at Cape Hatherton; more at twenty degrees south of the Arctic Circle than at any parallel north of it. The line of greatest snowfall, like the isothermal line, is irregularly extended, depending greatly on the wind-currents. The water of the southern winds condenses and falls as they reach the colder latitudes. Allowing the line of greatest snowfall to pass through Hudson Bay, it must have been far to the south of it during the ice period. At or near the forty-second parallel the glacier probably attained its greatest thickness. Here it intrenched itself to stay; and for a very long time the winter snows must have compensated for the summer thaws. While, therefore, that part of the drift-region lying farther to the south was uncovered, and the water-courses actively at work digging out their beds and draining the land, the whole country to the north was a field of ice. Simultaneously the ice and the line of greatest snowfall receded northward. As the day's greatest heat is not when the sun is on the meridian, but an hour or two later; as the summer's greatest heat is not when the sun is at its greatest altitude, but a month or two later; so it is probable that the highest average temperature has not yet been reached, and that the line of greatest snowfall is still receding toward the poles. This fact, if it be one, must presage for Arctic explorers wider and more open fields of work a thousand years hence than to-day.

The cause of the saltness of some American lakes is too patent to require many words of explanation. It is probable that, when the continents were raised from the sea, the lake-basins had been already formed, and came up, therefore, brimful of water. In the northern and eastern part of the continent, where the supply from rain and snowfall exceeds the loss by evaporation, the salt, being continuously carried away through their outlets, has become so diluted as to be an imperceptible quantity. In arid regions, as the Pacific slope and the country about the Caspian, where the evaporation was in excess of the supply, the water-level of the lakes continuously sank until, on account of the diminished extent of surface, the equilibrium of loss and gain was attained. Hence the exceeding saltness of Great Salt Lake, the Dead Sea, etc. For a like reason the water of the Mediterranean contains more salt relatively than that of the ocean. Evaporation exceeding the supplies from the rivers and rainfall, it requires a constant current through the Strait of Gibraltar. The same is true of the Red Sea, causing a like current through the Strait of Bab-el-Mandeb. Other salt or brackish lakes probably owe their saltness to the supplies from the land. Water being the most general of all solvents, the rains gather up the chloride of sodium from the soils and the disintegrating rocks, and where the streams fall into lakes whose only outlet is evaporation, the land itself must be a constant source of saline supply, and their waters must become more and more salt, until their capacity as a solvent has been reached.

The Utah Basin must once have been filled to its brim with ocean-water. The outlet has been evaporation. The lake, receding to its present level, has left many evidences of its former extent.

To the drying up of salt lakes is probably due the presence of rock-salt, often found in great quantities in regions of little rainfall.

I come, lastly, to the *trend* of the North American lakes. A good map, and especially one on the Mercator projection, will show that lakes are not dotted promiscuously here and there, with no regard to system. They have with each other a trend of direction often as well defined as mountain-ranges, or the coast-lines of continents. As already shown, the great American depression bifurcates at about the fortieth parallel, and nearly at right angles, into northeastern and northwestern branches, whose lines of direction lie respectively in approximate parallelism with the far-off Appalachian and Rocky Mountain ranges, and with the still farther-off Atlantic and Pacific shore-lines.

Geologists, and especially physical geographers, have noted the fact that the mountain-ranges, the shore-lines of continents, and the islands with each other, have lines of trend mostly northeastward or northwestward. The lakes of North America have similar trends of direction, and therefore form an integral part of the great system upon which the planet itself is built. This is as should be expected. That the line of greatest depression should have an approximate parallelism with the adjacent greatest upheaval is but a physical necessity.

Many thousands—perhaps millions—of years before man was on the earth, the Laurentian Hills were raised above the dark waters, their origin dating back to the very dawn of life on the planet. Both the primordial continent and the primordial life were the prophets—this of the higher orders of organism, and that of the continents and islands yet to be. This original continent has held its own. It took the initial in the building up of North America. Its two lines of direction had the form of a right angle, one projecting northeastward and the other northwestward.

This is the normal plan. It is the structural arrangement, not of this continent only, but of all continents; and the lake-depressions, conforming to the general system, are an additional witness to the common underlying laws and forces of which the earth itself is a grand phenomenon.

## LAWSUIT OR LEGACY.

By H. H. GARDENER.

WITHIN the past twenty years the business of life-insurance has grown with such wonderful rapidity, and changed so radically in its methods and contracts, that it is to-day as unlike its old self as the railway-car is unlike the stage-coach.

The old life-insurance contract undertook to define burglary, riot, and rebellion, and the companies held themselves free from obligations deliberately assumed, if the other party to the contract did not conform to the rules of conduct laid down under their definition and requirements. Nowhere else in the history of large business organizations has the debtor regulated his obligation by the morals of his creditor and liquidated his debt by acknowledging its existence, and then simply charging moral obliquity on the part of said creditor as the reason for not paying it.

If A owes B fifty dollars, and B is known to be a thief or a murderer, it does not liquidate A's debt to simply show that fact. But life-insurance companies have held, and some of them still claim, the right to so indemnify creditors, and, strange to say, they have been able to conduct business on that basis. They have even gone further, and said that a debt to B's heirs is forfeited in like manner—thus making the destruction of a man's reputation after his death of pecuniary advantage to the company. They have been enabled to do this because many men do not read the insurance contract which they sign, and hence have no idea of its complicated and, in many cases, unfair nature. If men insisted upon understanding the contract before they sign it, as they do in other business, the more unfair features would necessarily disappear from all insurance contracts.

If I deposit a thousand dollars in a bank, it is my money—I can withdraw it when I please, subject, of course, to business rules, which have nothing to do with my standing as a citizen. The bank has nothing to say in regard to my loyalty or my honesty in other affairs. My money can not revert to the bank on outside ethical or moral grounds. But in life-insurance—a business in which more money is invested than in banking—the opposite rule has been, and to some extent still is, in operation.

There were a few companies, it is true, which rarely took advantage of their reserved right to mulct a family of money actually received, upon the plea of outside ethical delinquencies of the dead—which had nothing to do with his length of life—and there are companies, at the present time, which have voluntarily eliminated the greater part of these oppressive regulations and reserved rights from their forms of contract. But in many of the companies they still remain in full force, and in almost all there are improvements of a most important nature needed even yet.

In other words, while one or two companies have made their contracts, in large part, what contracts purport to be, a guarantee of good faith—that, if so much money is paid to them during a stated interval, they will return to the party insured, or to his heirs, a stated sum at a given time—there are still many which have not so improved their contracts, and are doing business in the old way, depending for success on the ignorance of their applicants in regard to the unfair conditions of the contracts which they sign. A few have left out most of the thousand and one ifs and ands and provideds of the old *régime*, and have at last undertaken to conduct this important and rapidly-growing business on strictly business principles, and the results have abundantly attested the wisdom of the new departure and indicate the advisability of still more liberal measures. A man may now, if he is careful and wise in his choice of a company, insure his life, or, if insured, he may have the temerity to die, without a fairly-grounded expectation of leaving his family a lawsuit for a legacy. He may also be reasonably sure that he is not placing his own reputation (after he is unable to defend it) at the mercy of a powerful corporation intent upon saving its funds from the inroads of a just debt. And I question if it is too much to say that, given enough money, a strong motive, and a powerful corporation, on the one hand, and only a sorrowing family upon the other, and no man ever lived or died whose reputation could not be blackened beyond repair, after he was himself unable to explain or refute seeming irregularities of conduct or dishonesty of motive. No man's character is invulnerable, and no man's reputation can afford the strain or test of such a contest. Millions of dollars have been withheld from rightful heirs by threats of an exposure—the more vague the more frightful—of the unsuspected crimes or misdeeds of the beloved dead.

Thousands of cases never known to the public have been "compromised," and hundreds of heart-aches and unjust suspicions and fears about the dead, which can never be corrected, are aroused in sorrowing but loving breasts by this method of doing "business." It is, of course, of the utmost importance that every precaution be taken by life-insurance companies to protect the funds held by them, in trust for others, against fraud and trickery. But with the agent, the examining physician, the medical directors, and the inspectors all employed by, and answerable to, the company represented, if fraud is committed in getting into the company, one or all of these paid officers must almost, of necessity, be party to that fraud. With all these safeguards in the hands of the company, if a man is accepted as a "good risk," if he pays his premiums, surely his family has the right to expect a legacy and not a lawsuit, nor a "compromise" which *must* cast reproach on the dead.

If it were not for the enormous value and benefits of this method of making provision for his family, surely no man in his senses would ever have risked—would not risk to-day—signing a contract which gives the other interested party not only an absolute fixed sum of his money, year by year, but also reserves to itself the right to investigate and construe his actions and motives after he is unable to contest its verdict.

And not only this, but upon the finding of some slight, wholly immaterial flaw in his statements (which it failed to find when he was in the hands of its agents and officers), in some companies he not only forfeits the right of his heirs to their purchased inheritance, but the company retains his money which he has paid in besides! This is surely a dangerous contract for any man to sign. It is placing a temptation and a power in the hands of a corporation that it has never yet been in the nature of corporations not to abuse.

"If any statement in this application is in any respect untrue, it voids the policy, and all payments which shall have been made revert to the company," gives a wide field and doubtful motive of action when it is remembered that many of the questions are of such a nature that not one man in a thousand could be absolutely sure that he knew the correct reply.

"At what age did your grandparents die?" All four of them. How many men are sure that they can answer that question correctly? "Of what did each one die?" You do not know. You have a general idea. You express it. You pay your premiums ten years. You die (one doctor says of consumption—another says of blood-poison); the company finds some old person who says your grandmother on your father's side died of the same thing, and there is a rumor that a long-forgotten (or never-known) country cousin also had it.

The company sends a representative to the widow. He assures her (and by the very terms of the contract, signed by the dead husband, he is right and she is helpless) that they can refuse to pay a cent; that her husband got his policy by fraud—although no indication of his physical disorder appeared to any of the numerous officers employed by the company for its own protection, when he made his application, and by general reports he was (and believed himself to be) a sound man.

He assures her that they want to be generous rather than just, and if she will sign a release, or "compromise," she will be given a small part of the sum named in the policy. He makes her feel the necessity of keeping this bargain a secret, lest other policy-holders object to the company paying anything on the life of one who "attempted a fraud" upon them! He impresses upon her that in case of contest she could get absolutely nothing; that she is poor, and the company is rich and strong; and if he fails to arouse her gratitude for his generosity in offering to pay her anything whatever, he usually succeeds in intimidating her in her poverty and distress. A sparrow in the hand is worth more than an eagle on Mount Washington to a widow with a hungry family, especially if the eagle has successfully maimed his pursuer in the beginning of the flight.

The company knows this. The widow knows it. The conclusion is therefore certain before the premises are stated, and the "compromise" is made or the claim quietly dropped. It is easy to say that a man died of some bad habit unknown to his family, and his family would rather forego their claim than drag into light, or into disgrace, the memory of the loved dead. All this is well understood by those on the "inside," and by thousands of sad hearts that dare not speak. Is there no remedy for all this? Is there no way that a useful and powerful business can be rid of features which make it both dangerous and ghoulish?

The recent steps taken by the best companies are undoubtedly in the right direction, as those still using the old forms of contract will sooner or later learn. But there is room yet for improvement even in the best forms written to-day. The fairest insurance contract written still has room for improvement.

Is there no way to protect these great corporations against the frauds of individuals, and at the same time protect the individual against the frauds of the corporations?

Must life-insurance contracts be absolutely one-sided, and that be the side of the strong against the weak; the guarded against the unguarded; the living against the dead? It seems to me that this is wholly unnecessary. A life-insurance company which has the agents, the doctors, the medical directors, and inspectors all on its side can well afford to offer a fair field—a plain, fair contract—to its patrons, and then pay its debts like any other debtor when its obligation falls due. If it can not find out within a year (with all the machinery in its own hands), and while the man is alive, that he is a bad risk, it is too late to make the discovery after he is dead. If the indications are sufficiently in his favor for them to accept his money from year to year while he lives, they are sufficiently favorable to him for his family to receive the company's money when he has died.

Life-insurance is too valuable and too necessary a means of provision for the family for it to be overlaid with abuses that make many men hesitate to avail themselves of its benefits; and which put a power for evil into strong hands, and make temptation to do wrong inevitable and constant.

It is said by some, whose attention has been called to this important subject, that the form of contract does not so much matter, since almost any court or jury will decide a suit against the company, and in favor of the family, in any event. This is taking it for granted that the heirs are in position, and are willing, to bring suit, and risk the reputation of the dead as well as the financial drain. But, as a matter of fact, this is not true—nor is it desirable that it should be. The rights of these corporations should be as jealously guarded by our courts as the rights of the individual; and perverted justice is a dangerous tool to handle. The man who signs an oppressive contract depending upon a court to nullify it after he is dead, is clinging to a rope of sand. The letter of the bond is what the court is bound to enforce, and every man should be sure that he signs only such as shall deal fairly with his heirs *on that basis.*

The following extract is from the decision of the Court of Appeals in the famous Dwight case, which is so recently decided as to most forcibly illustrate this point:

"If an insurance policy in plain and unambiguous language makes the observance of an apparently *immaterial* requirement the condition of a valid contract, *neither courts nor juries have the right to disregard it* or to construct, by implication or otherwise, a new contract in the place of that deliberately made by the parties. . . . Such contracts are open to construction, . . . but are subject to it only when, upon the face of the instrument, it appears that *its meaning is doubtful* or its *language ambiguous* or *uncertain*. . . .

"An elementary writer says: 'Indeed, the very idea and purpose of construction imply a previous uncertainty as to the meaning of a contract, for when this is clear and unambiguous there is no room for construction and nothing for construction to do.'"

For this reason the Court of Appeals cited as the ground, and the *only* ground, for its decision against the widow, the following clause from the policy of the contesting company:

"This policy is issued, and the same is accepted by the said assured, upon the following express conditions and agreements: That the same shall cease and *be null and void* and of no effect . . . *if the representations* made in the application for this policy, upon the faith of which this contract is made, shall be found in *any respect* untrue."

Colonel Dwight was in the habit of making large business ventures. Several times, when he had done so, he had taken heavy amounts of life-insurance, so that in case of the failure of his undertakings, and his own death before he could regain his financial feet, his family would not suffer. On previous occasions he had dropped the greater part of his insurance as soon as his business ventures had terminated successfully. This is not an uncommon thing for rich or speculative men to do.

In 1878 Colonel Dwight died, with an insurance on his life of about $265,000, some of which he had carried for years; but a large part of it had been recently taken for the reasons above stated, and as he had done before under similar circumstances. Fifty thousand of this sum was in old and new policies against one company.

This company paid at once, thus giving the widow means to fight for her claims against the other companies. In a short time one of the other companies, against which she had a small claim of $5,000, also paid. The other *nineteen* companies contested. The widow employed Senator Conkling, and the fight has been the hardest, the bitterest, and the most ghoulish insurance contest ever had in this country; and finally the companies have won in the Court of Appeals on a purely technical point, after having dug Colonel Dwight's body up several times, in the effort to prove that he was poisoned, that he hung himself, and that he was not dead at all! They failed utterly to prove any *material* cause of contest; but they finally won on the ground that, in answering a question in the application for insurance, Colonel Dwight did not state that he had ever engaged in the liquor business, whereas it had been known that he had owned a hotel where liquor was sold.

Now, when it is remembered that at one time these companies tried to prove that Colonel Dwight had committed suicide, but that they never had any grounds upon which to claim that he had died of intemperance, the purely technical grounds for the decision of the Court of Appeals is apparent. Ninety-nine policies out of a hundred could be contested on such ground as that; and so long as insurance contracts retain these unreasonable and oppressive features, no man can be sure that he is not leaving a lawsuit and bitter sorrow to his family, and worst of all a blasted reputation for himself, when he applies for insurance under such a form.

An officer of one of the companies was heard to boast of the fact, but a few days ago, that his company had spent nearly *ten times* the amount of the claim against it in this Dwight contest! This is economy indeed! Whose money was thus spent? The policy-holders'. For what? To defeat one of the policy-holders in a contest for a claim no doubt as honest as any one of the others will present in his turn.

But suppose that this was not an honest claim; suppose that Colonel Dwight was not a "good risk," is it not a rather suggestive indication of the value of the medical examinations by the expert medical examiners and directors of twenty-one life-insurance companies? A risk good enough to "pass" some forty-five doctors employed by, and for the protection of, the companies is, on the face of it, a good enough risk to pay. If this is not so, then the companies, and not the public, should be made to bear the responsibility of the incompetency of their own officers.

But for the reputation of these medical men, it is a fortunate fact that the contest did not prove Colonel Dwight to be an unsafe risk. After his body was dug up several times, and a number of autopsies held, and most of him analyzed, they succeeded in proving that he owned a hotel where liquor was sold!

But under these forms of contract, the companies undoubtedly had a legal right to refuse payment upon even so absurdly technical a misstatement of "occupation." It was claimed that his hotel was a side issue; that he did not think of himself as in that business, and that his failure to say, because of it, that he was "in any way connected with the manufacture or sale of spirituous liquors," was a natural one under the circumstances. How many men give, in answering the question as to occupation in their applications for insurance, *all* of the numerous "plants" in which they have an interest of a financial nature, more or less important? One man says he is a book-keeper, but he may possibly, also, own stock in a mine. His claim could be contested on that ground. Suppose that he really thought nothing of his mining-stock when he made his application and signed his contract? Suppose that in a short time he was called to see the mine, went into it, and died of the results of that trip? His policy would not, if it contained the usual conditions, be worth, in a legal fight, the paper it was written on.

That companies often waive their reserved right to contest on such grounds, is used as an argument to prove the innocent nature of these forfeiture clauses and other oppressive conditions. But so long as they hold the legal power to do so, the temptation to contest will be too great for flesh and blood, not to say for corporations, to bear without yielding sometimes. The "Get thee behind me, Satan," of a fair, plain contract will be the best safeguard for the heirs in the matter of money, and for the companies in the matter of morals; while the "economy for the sake of surviving policy-holders" might be directed, as there is surely room for believing that it needs to be, into other and more legitimate channels. Economizing on debts to dead policy-holders is not a very good recommendation to living ones, for the companies which thus lock the wrong stable-door.

The new move toward furnishing fair contracts is in the right direction, and it now rests with insurers—the public—to see that it does not stop short of fulfilling the promise of still better things in the future.

# AMONG THE "THOUSAND ISLANDS."

By GRANT ALLEN.

"THE humming-bird has now laid its eggs in the nest by the veranda," our friend wrote us from Gananoque; "come soon if you want to see them. And Miss Sinclair has tamed a chipmunk, which eats almost from her hand, by the big tree. I'm sure your boy would like to have a peep at him. Also, the Indian-pipe plant is beginning to flower in the wood behind the house. It doesn't last long; you must make haste, or you will be too late for it."

We knew the hospitable chalet at Gananoque of old; and even if our friend's society had not been enough of itself to entice us (which it amply was), the added delights of a humming-bird's nest, a tame chipmunk, and the Indian-pipe plant in full flower might surely have sufficed to move the heart of the stoniest of parents. I don't go in, myself, for being what you may call stony; on the contrary, where the junior branches are concerned, I acknowledge myself but as clay in the hands of the potter; so the very next day saw us safely packed on board the Princess Louise river-steamer, three precious souls, and all agog to dash through thick and thin on the heaving bosom of the broad St. Lawrence.

And the broad St. Lawrence *did* heave that July evening, no mistake about it. A fresh west wind was blowing over the lake, and the spray was dashing up with sea-like violence as we steamed away from the wooden wharves of Kingston, heading down-stream for the Thousand Islands. Lake Ontario, when it chooses, can get up a very decent storm indeed; quite as fine a storm as any to be seen upon the German Ocean, with huge four-masters from Chicago stranding helplessly on the reefs and spits; and even the river can run seas-high in its broader reaches among the wide expansion known as the Lake of the Thousand Islands. Now, Gananoque is the petty metropolis of the Thousand Island district on the Canadian side, as Alexandria Bay and Clayton are on the American shore; and the Princess Louise is the little steamer which plies daily between Kingston and Gananoque during the summer season, when the ice is up and navigation is open. But I have always found European ideas as to the geography of Canada so very vague that I shall make no apology for beginning my story with some slight account of the Thousand Islands and their immediate surroundings.

Just at the point where the huge St. Lawrence emerges lazily from Lake Ontario—or where Lake Ontario narrows into the St. Lawrence, whichever you will—the bed of the river crosses a transverse range of low granite hills, whose bare summits have been ground into dome-shaped bosses (or *roches moutonnées*, as they say in Switzerland) by the enormous ice-sheets of the Glacial epoch. The granite of the chain is very hard and pure ; it is quarried in large masses, indeed, for monumental and building purposes, among these very islands ; and so the great river, unable to cut itself as profound a channel as it might otherwise have done in a more yielding rock, has spread itself out in wide pools over a broad and shallow bed, only deep enough for large navigation by river-steamers in two or three well-recognized currents. The main line of the Grand Trunk Railway, in fact, between Kingston and Montreal, traverses this same low, granite range, and exhibits very clearly the conditions precedent for the production of so strange and beautiful a phenomenon as the Thousand Islands. The range consists of numerous crouching, ice-worn mounds or hillocks, shaped exactly like a pig's back—or, to be more respectful, let us say an elephant's, or a basking whale's—while in between them lie deep grooves, or valleys, equally ice-worn, all running parallel and scratched alike, as is necessarily the case with the grooves due to the downward movement of a single great glacier or ice-sheet. Now, the average width of the St. Lawrence under normal circumstances, when it isn't trying, Yankee fashion, to do a big thing, is about a mile or a mile and a half. But when it encounters this belt of ancient ice-worn gneiss, with its accompanying dales, it spreads itself out into a sort of encumbered lake some ten or fifteen miles wide, filling up the grooves and interstices between the rounded humps, but leaving the higher mounds or hillocks themselves as tiny islands intersected by endless miniature channels. The name Thousand Islands is by no means due to characteristic American exaggeration : the official survey, made for the Treaty of Ghent gives the number as sixteen hundred and ninety-two, and they extend for forty miles down the river from Kingston to Brockville, in a perpetual succession of beautiful pictures.

If the islands and islets still remained merely in their original condition, as rounded, dome-shaped knolls, clad with pine and maple and Virginia-creeper, rising hump-like in slow slopes from the water's edge, they would still be extremely romantic and picturesque. But they are far more than this. The ceaseless action of the river at their sides, aided by the disintegrating frosts of winter, and the pressure of the ice-packs when the lake "breaks up" in early spring (exactly as if it were an academy for young gentlemen in the Easter holidays), has cut many of their edges into steep little cliffs, fantastically weathered, as granite almost always weathers, into beautiful broken crags and pinnacles. Thus the cliffs often spring sheer from the surface of the water, worn by rain and frost into quaint, jutting shapes, and with rare ferns and flowers and creepers hanging out here and there from their creviced nooks. The summits remain for the most part smooth and polished by the old ice-action ; and the contrast between their bald, round surfaces, almost gray with age and lichens, and the jagged and ruddy outline of the more recent fractures, makes an extremely bold and effective element in the total picture. The islets are also of every imaginable shape, size, and grouping—some of them big enough to hold two or three farms, and others of them rising solitary from mid-stream, crowned by a single waving stem of Canadian cedar. Here is one, for example, a mere bare pinnacle of moldering rock; and here is another, a craggy little island, yet covered with endless variety of timber, whose drooping foliage hangs over the bank and reflects itself placidly in the silvery mirror below. Thus cluster after cluster passes before one's eyes, all fairy-like, green, and romantic, but all as infinitely varied in shape and contour as intricate intermixture of rock and vegetation, and land and water, can possibly make them.

I must give the reader due warning, however, that on this ground I am perhaps a trifle enthusiastic. To say the truth, if I may for once be frankly personal, I speak with the pardonable partiality of a native. I am, indeed, an aboriginal of this very district, born at Kingston, the threshold of the St. Lawrence, and "raised" (as we say beyond the Atlantic) on the biggest and longest of the Thousand Islands. Hence, something of the glamour of childhood surrounds the region still in my eyes: sweeter flowers blow there than anywhere else on this prosaic planet; bigger fish lurk among the crevices, bluer birds flit between the honeysuckles, and livelier squirrels gambol upon the hickory-trees, than in any other corner of this oblate spheroid. I see the orange lilies and the lady's-slippers still, by the reflected light of ten-year-old memories. So the cautious reader will perhaps do well to take a liberal discount of twenty per cent off all my adjectives, to submit my eulogistic verbs to a strict *ad-valorem* drawback, and to accept the remainder as probably representing an unprejudiced view of the situation. I am not, I will admit, a patriotic Canadian—in so small a community patriotism runs perilously near to provincialism—but I must allow that a warm corner still exists in my heart for the rocks and reaches of the Thousand Islands.

The Princess Louise steams down the Canadian Channel—one of the two chief navigable currents—past Wolfe Island, where I spent a rustic boyhood with the raccoons and the sunfish, and on through endless groups of other wooded islets, with cedars sweeping low to the water's edge, till, after a couple of hours aboard, two white wooden lighthouses, guarding the entrance to the little harbor, announce our approach to Gananoque. A "creek," or minor river (pronounce it "crick" if you wish to be thoroughly transatlantic), here joins issue with the great St. Lawrence, and of course on its way indulges in some local waterfalls, once pretty, but now made to do duty, alas! with American utilitarianism, in turning the saw-mills which are the *raison d'être* of the flourishing small village. I will not describe Gananoque itself—Canadian villages are best left to the imagination of the charitable reader; I will only say that its natural situation is absolutely charming, and its bay and outlook "as beautiful as they make them."

The Princess Louise drew up at the rough log wharf, choked with immense piles of white-pine planks—" lumber," as the American language gracefully phrases it ; and even as we reached the tiny quay we saw our hostess in her row-boat, already pulling round a granite bluff from her retreat to meet us. By private arrangement with the captain, indeed—so sweetly simple and domestic is life in these new countries—the engineer " scooted," or blew, his whistle three times as he passed the lighthouse whenever he had visitors on board for our friends' chalet. The moment the " scoot " is heard on the cliff, the chalet folks put out their boat at once, and row round to the landing-place to take up their visitors without delay on arrival.

It is one of the charms of our vast England that here a man is lost in the crowd. The individual withers (much to the advantage of his own comfort), and the world is more and more. You can walk along the streets of London any day with the serene consciousness that nobody knows you or cares a pin about you, that to all the passers-by you are merely another nameless passer-by, that your personality is wholly merged in the recognition of your abstract existence as a single unit of assorted humanity. That, I say, gives a man a delightful sense of breadth and freedom. You feel yourself planted, as the inimitable Prince Florestan aptly phrases it, " at the strategic center of the universe, for so I may be allowed to style Rupert Street," with your individuality wholly obliterated, in the general consciousness of our common human citizenship. But once in a while, as an incident of a summer holiday, it is not wholly unpleasant, by way of contrast, to find one's self for a time in such a narrower world of mutual recognition, where the purser knows immediately you are going to stop with your friends in their summer quarters, and gives notice to the engineer to blow the whistle thrice accordingly as you pass the chalet where they presently abide. A certain patriarchal colonial note in it all attracts one's not unfavorable attention. If you were a duke in England, the constituted authorities would refuse to whistle for you ; it is agreeable now and again to feel yourself a duke, and to be recognized and whistled for with more than ducal consideration. I much prefer it to the South Coast Railway style, where my urbane inquiry, " Is this the train for Brighton, please ? " meets with the crushing response from guard or porter, " All right ! third class forward ! "

We disembarked from the Princess Louise, and took our seats in the chalet row-boat. Our hostess pulled ; politeness compelled me to offer myself as an unworthy substitute, but, when she firmly declined to surrender the sculls, I felt a secret twinge of satisfaction, for though it's one thing to pilot a dingey from Oxford to Sandford Lasher, it's quite another thing to pull a heavy hen-coop against the big waves of the full St. Lawrence on a windy evening. Canadian ladies think nothing of a mile or two of rowing, or of a stiff breeze ; and modesty recognized the palpable fact that the sculls were in far more competent hands. Practice makes perfect, however; and a few weeks in Canada soon brought back to me the old knack of rowing with thole-pins instead of rowlocks, though to the last the instinctive tendency to drop the wrist in the vain effort to feather—feathering, of course, is impossible with the pins—persisted always, much to my discomfiture.

The chalet, whither we were bound, stands a little removed from Gananoque village, in wild grounds all of its own, raised high among the woods, on top of a sheer cliff, beneath whose frowning crags we rowed into a little bay or haven, protected by a bold granite headland from the sea, that rolled high upon the open river. There we pulled up beside the floating wooden landing-stage, and disembarked on the grounds of Mossbank. (The real name was not Mossbank, but something very much prettier and more appropriate, only my friend's solemn adjurations have bound me down by inviolable promise not to reveal either its local habitation or its name too openly to the profane vulgar, or even, which is quite another matter, to the candid reader of this present magazine.) I forget how many steps, partly wooden, and partly cut into the solid granite of the headland, led up the face of the perpendicular cliff from the water's edge to the chalet platform. I was told at the time—something like one hundred and ninety, I fancy; but the beautiful picture of that calm bay, and the hanging woods, and the maiden-hair fern springing in wild luxuriance from the clefts of the rock, and the bearberry clambering over the ice-worn bosses, and the wild sarsaparilla raising its green berries on its tall, bare stalk, and all the thousand and one exquisite details of frond and foliage, and fruit and flower, distracted my attention from arithmetical facts, gradational or otherwise, and left me only eyes and mind for the beautiful scene that unrolled itself slowly, step by step, before me.

At the summit, on a rounded, rocky plateau of bare granite, overgrown in places by clambering shrubs and trailing Western creepers, the chalet itself fronted the Sunset Islands, and looked down from its aërial perch upon the intricate maze of russet land and purple water. To the right lay the lighthouses and the islands in their neighborhood; in front, one islet behind another stood massed in view, backed up by the low hills of the New York shore; to the left, the high cliff closed in the sight, with a single rocky island rising full in prospect, and the river stretching illimitably onward, broken by endless tiny archipelagoes, in the direction of the Cornwall Rapids. For the chalet itself, how shall I fitly describe it? A more charming summer-house was never devised for human habitation. Being meant for midsummer use alone, warmth and snugness were left wholly out of consideration; all the stress was laid upon coolness and breeziness in the sweltering heat of Canadian August. Inside and out, the chalet was scrupulously of wood, wooden; it was built of the native white pine, polished both sides, one thickness of boards only, and all the constructional details within and without were plainly visible to the naked eye in a way that would have delighted the honest souls of Scott and Fergusson. The inner walls showed the polished framework (like a good church-roof) that supported the single layer of planks, unpapered, and otherwise undisfigured ; the polished beams and joists overhead bore the weight of the boards that formed at once the ceiling of the drawing-room and the floor of the neat little bedrooms up-stairs. Thus every room had six sides of polished light-brown pine-wood—floor, ceiling, and four walls. A few delicate Oriental rugs and native fur-skins lay daintily upon the waxed floor ; etchings and sketches hung upon the walls ; light and graceful summer-like furniture filled up the rooms ; but otherwise all was the clean wooden framework, and delightfully cool and appropriate it looked. Further to carry out the summer effect of the whole, the three reception-rooms on the ground-floor, instead of being jealously partitioned off from one another with the stereotyped formality of urban life, were thrown into one by broad archways, where folding-doors might have been, but were not, so giving an air of roominess and freedom to drawing-room, dining-room, and library alike, which was especially grateful in hot Canadian noontides. With doors and windows flung wide open, and roses and honeysuckles peeping in from the richly festooned pillars of the veranda, can one imagine a more delightful spot in which to spend a cloudless summer?

For, to complete the charm, a veranda ran round the house below, with broad shade and comfortable rocking-chairs, and creepers clambered up the posts around, making, as it were, a rustic frame for the exquisite picture of river and islands that lay beyond. Up-stairs, each bedroom opens out onto a continuous balcony, formed by the roof of the veranda, and running round the whole chalet, Swiss or Norwegian fashion, with a wood-work balustrade, overgrown with lithe sprays of native climbers. The view from the balcony was even finer than that from the platform of rock on which the house stood ; it opened up yet wider vistas of the river, and gave a broader prospect over the blue hills of the dim American shore beyond.

I have been thus particular in describing the house at Mossbank, because it may be taken as a fair sample of the delicious little summer cottages in which Americans and Canadians lounge away the sultry months of the transatlantic season. Our hostess, indeed, who combines the artist's eye with the poet's, had been peculiarly happy in her choice of a site : Mossbank stood on, by far, the prettiest point we saw anywhere among those sixteen hundred and ninety-two fairy-like islands ; but almost all the cottages we visited were picturesque and appropriate to their use and situation, though none other, perhaps, was quite so graceful in its design, or so dainty in its appointments, as the one in which we were fortunate enough to fix our headquarters. Dozens of such cottages now stud the prettiest parts of the various channels, and it is locally fashionable to run them down as disfiguring and modernizing a beautiful piece of rustic wild scenery. For my own part, though I have known the islands intimately from childhood upward, and can remember them when their only inhabitants were minks and musquash, and their staple products blueberries and wild-flowers, I do not think the quaint little cottages and the wooden bungalows are anything other (in most cases) than improvements to the district. And I am rather a Puritan, too, in this matter of wildness. I hate the intrusive foot of civilization. But civilization, as it shows itself among the Thousand Islands, is not intrusive; it rather heightens than detracts from the total impression. By themselves, the islands tend toward sameness; a graceful chalet, a light wooden toy farm-house, a white, gleaming lighthouse, judiciously planted on a jutting height, and well embowered in spruce-fir and maples, give individuality and distinctiveness to the picture, and supply the landscape with what it otherwise sadly lacks—*points de repère*—in the tangled maze of wood and water. Every view is all the better for an occasional landmark; the wildest nature is somewhat improved by a stray token of man's occupancy and the possibility of intercourse with the mass of humanity.

For, except the cottages, the islands have been mostly left by the common good taste of their owners and occupiers in their native wildness of rock and foliage. No foolish attempts have anywhere been made at the outrage known as landscape-gardening: the granite crags and the festoons of wild-vine or Virginia-creeper have been wisely retained in God's own handywork. The grounds of Mossbank, in particular, were especially charming. In front of the house the bare platform of rounded granite gave place here and there to irregular patches of shallow greensward, in which a few bright flowers grew as if naturally, while native shrubs found a firm foothold in the deep dikes weathered at joints in the solid rock. All round stretched rich Canadian woodland, carpeted with undergrowth of blueberry and poison-ivy. From the edge of the cliff, which toppled over sheer I know not how many hundred feet into the river below, one looked down into pellucid depths of limpid water, where even from so great a height the bass and pickerel might be distinctly descried waving their restless fins against the black background of rock at the bottom. Everywhere around lay delicious spots where one might fling one's self at one's ease on the smooth gneiss, almost as polished as if by a lapidary's wheel, and pick sweet flowers from the crannies between—flowers of that beautiful exotic Canadian woodland type, so different from our weedy European pattern.

On one side, a little back of the chalet (which could practically be approached by water only), lay a deep ravine whose bottom was filled with rich peat-mold, the home of innumerable exquisite ferns, a paradise for the botanist, pregnant with hints as to Nature's ways among the flowers and insects. I could linger here for hours discoursing of the strange and lovely plants that grew profusely in that shaded dell, only I'm afraid the courtesy of the proverbially courteous reader would scarcely survive so severe a strain upon its well-known indulgence. I will hurry on to the boat-house, therefore, which lay at the riverward mouth of the deep ravine, and formed, so to speak, the *embarcadère* for everywhere; for the river is, of course, the true highway of the Thousand Islands, and the boat is the gig by which one effects communication with the outer world, and pays one's visits to friends and neighbors.

Indeed, among the islands one lives upon the water. By a certain tacit understanding between the islanders, every resident has a recognized right to explore every other resident's petty domain. No obtrusive notice-boards flaunt before the innocent face of heaven the anti-social and wholly uncalled-for information that trespassers will be prosecuted with the utmost rigor of the law. On the contrary, the usual formula painted on the neat little placard beside the tiny landing-stages assumes the optative rather than the imperative mood: "Parties landing on this island are requested to kindly abstain from damaging the ferns and flowers." The fact is, all the islanders are there as summer visitors only; each possesses but a tiny realm of his own, often beautifully varied, but always readily exhausted of its native interest; and the whole charm of the spot would evaporate entirely if proprietors insisted with ingrained British churlishness upon their legal right to shut themselves in from landless humanity with the effectual protest of a high brick wall. Accordingly, everybody always lands freely, no man hindering, upon everybody else's private island; and the day is mostly passed in wandering (afloat) in a delicious, aimless, listless fashion down tiny channels between islet and islet, stopping here to pick a rare wild-flower from a cliff on the side, and halting there to explore and climb some jutting rock whose peak promises a wider view over all the surrounding little archipelagoes.

Many of the islands are still uninhabited, and these are the best of all for botanizing purposes. It is there that you may find the Indian-pipe plant, known also by the still stranger and truer name of corpse-weed; a beautiful drooping white flower, as pale and soft in its material as a fungus, of which our hostess said to us prettily: "When I first saw it I was half afraid to touch the uncanny thing. I thought I had found the ghost of a flower." It is, in fact, a lily-like flowering-plant; a heath by family, which had adopted the habits and mode of life of a fungus, living entirely like a parasite on the decaying foliage beneath the forest-trees, and has therefore lost its green leaves and assimilated in all unessential particulars to the other fungi whose ways it mimics. But I have promised not to be botanical here, so I will refrain from cataloguing all the other wonderful and lovely things to be found on these little island Edens. I will only say in passing that the scarlet columbines, the pinky-white water-lilies, the crimson baneberries, and the snowy anemones combined with the creepers, the ferns, and the club-mosses, to make as beautiful and varied a carpet as any I have ever beheld anywhere.

Others of the islands have chalets or cottages perched upon their tops, and to these we often rowed through devious channels, trailing a spoon, for black bass, behind, and catching for the most part nothing more valuable than water-lily leaves and Canadian river-weeds. Sometimes a cottage will occupy a single rocky islet, and its grounds will extend to two or three adjacent ones, connected with the home island by rustic bridges, just arched sufficiently to allow a boat to pass easily beneath them. On the American side, the picturesqueness of the scene is occasionally marred by too profuse a display of the national bunting: Canadian loyalty, though sometimes also a trifle obtrusive, seldom indulges in so lavish an ostentation of the British ensign. There are islands, too, where an ill-advised proprietor has had the bad taste to paint up the name of his domain on a big board—"Idlewild," or "Sunnyside," or "River Home"—as though the rock were a railway-station, and the porter were at hand to shout out in incomprehensible syllables, "Change here for Montreal and Chicago."

Few modes of life could be more graceful or humanizing than summer life in these delicious archipelagoes. Here and there, to be sure, as at Thousand Island Park, a whole big island has been bought up by speculators (oddly mixed in the making with camp-meetings and other revivalist religious gatherings), and laid out as a sort of exclusive Bedford Park, where none but approved members of a particular sect may take a cottage. One such little summer village is exclusively Methodist, while another is wholly given over to serious Congregationalism. But in most parts of the group (and it must be remembered that the islands cover, roughly speaking, an area of forty miles by ten or fifteen) each house occupies a little insular kingdom of its own, where the boys and girls can swim, and fish, and play, and flirt, unmolested; where the seniors can lie in hammocks under the trees, and ruminate on politics, philosophy, and the tender affections; where callers can be espied from afar as they approach the shore; and where hospitality on a simple scale is as universal as it is unexacting. Note, also, that big black bass and muskallonge still lurk among the cracks and crannies of the submerged granite, and that on many islands you can sit on the jutting end of a tiny promontory and drop your line for them, plump from the shore, into twenty feet of clear green water.

One last word to the British tourist who, stirred by my natural and indigenous enthusiasm, may perhaps contemplate some day visiting and exploring the Thousand Islands. Don't for a moment suppose that the islands can be adequately seen from the deck of one of the big lake-steamers that ply up and down between Montreal, Kingston, and Toronto. This is the stereotyped British-tourist way of seeing them, and nothing could be flatter or more disappointing. If you take them so, I do not doubt you will come away objurgating me by all your domestic deities. The steamer sticks to one or other of the two main channels, which are wide and deep, and comparatively unencumbered by rocks or islands ; it avoids the tiny minor reaches, rich in endless surprises and varying vistas which constitute the real charm and beauty of this fantastic, fairy-like region. No, no ! to see the islands properly, you must live on one of them for several days at least, and row up and down among the lost side-channels and tangled back-waters, exploring the petty bays and inlets, and occasionally losing your way altogether among the endless intricacies of that maze of water. But if you can not afford the time to see them thus, you should at least spend a day or two at Clayton or Gananoque, and take the "round trip" on the little excursion-steamer, Island Wanderer, which threads its way in and out through the loveliest windings of the landlocked river.—*Longmans' Magazine.*

## HUMAN BRAIN-WEIGHTS.

By JOSEPH SIMMS, M. D.

ALTHOUGH we may regard it as fully admitted that the external appearance of the skull is no certain indication of the mental caliber of the individual, still there are many who are inclined to measure mind in terms of matter, believing it to be somehow dependent on the material constitution of the brain. Texture, the relative proportions of white and gray matter, and especially weight, are regarded as important factors in the problem, and it is on this latter subject that I have compiled and would offer what, so far as I have been able to ascertain, are trustworthy data concerning the weight of this important organ. The average brain-weight appears to be higher in cold than in warm climates. The "Lancet" has recorded the observation that men with large heads endure cold better than those with small ones. The Lapps have the largest heads in Europe in proportion to their stature ; Norwegians next ; then come Swedes, Danes, Germans, French and Italians. The Arab head is smaller than any of these. In the Pacific Ocean, far to the north, a people called Chugatshes, with remarkably large heads, occupy the shores and islands of Prince William Sound.

The average size of brain differs also at different stages of life ; so that two men, each examining several hundred brains in the same city, may not obtain exactly the same results ; because the subjects of the one may be chiefly aged, and those of the other young, though mature. In this case the latter would show a much greater average weight than the former, because of the natural decrease of the brain with advancing years. The following acknowledged authorities have presented the facts as they found them, after weighing a large number of brains :

Dr. John Reid, of the Royal Infirmary, Edinburgh, states the average weight of the encephalon at the age of from five to seven to be forty-three ounces, ten drachms; from twenty to thirty, fifty ounces, nine and a half drachms. The female brain in the human species is generally lighter in mature years than the male by five ounces, or ten per cent, while her stature is only eight per cent less.

Dr. Peacock gives an average of one hundred and thirty-one male brains, between twenty-five and fifty-five years of age, as fifty ounces, three drachms. Dr. Austin Flint, of New York, estimates the male encephalon at 50·2 ounces. Dr. Thurman considers the average brain-weight of ordinary Europeans to be forty-nine ounces. This average may answer for Europe in general, but it would be too small for the colder regions, as shown by the averages of Dr. Reid and Dr. Peacock, taken in Edinburgh, as also it would be too little for New York, according to Dr. Flint.

In Italy, Greece, and Spain, the average is smaller than Dr. Thurman's, and in France, M. Bourgery finds the average weight of the male adult brain to be 46·6 ounces.

The average male brain-weights of different nations is given at—

50·3 oz. from 105 English and Scotch. (Peacock).
49·1 oz. from 18 Germans. (Wagner.)
48·7 oz. from 40 Germans. (Huschke.)
47·3 oz. from 50 Austrians. (Wiesbach.)
47·0 oz. from 28 French. (Parchappe.)
45·4 oz. from 8 African negroes. (Broca.)
43·6 oz. from 7 African negroes. (Various authors.)

We borrow the above table from Dr. Paul Topinard's "Anthropology," 1878, page 311.

To this we add the following average brain-weights, taken from the "Anthropological Review" of 1869, pages 190–192. If we compare the average weight of the African negro brains given in the above table with those of the full-blood negro brains taken from the one hundred and thirty-nine negroes raised in the United States of North America given below, it will be seen that the colder climate of the United States produces heavier brains in the negro than the warm climate of Africa:

| | | |
|---|---|---|
| 139 negro brains in United States averaged | 46·9 oz. | avoirdupois. |
| 1 Guinea negro | 44·4 oz. | " |
| Hindoos' mean brain-weight | 44·2 oz. | " |
| 3 Ashantees averaged | 42 9 oz. | " |
| 1 Fantee | 41·6 oz. | " |
| 2 Congo negroes averaged | 39·7 oz. | " |

Dr. A. Wiesbach, a famous investigator of brains in the Austrian Empire, states that the heaviest are found among the Czechs; those of the Roumani are somewhat lighter; the Magyars or Hungarians lighter still; yet their brains average eight grammes more than the Germans of this empire; while the Italians are the smallest of all, being about

25·21 grammes less than the Roumani. The South Slavonian brains are somewhat heavier than the Italian, but lighter than any of the other peoples. One third of the Austrian Empire is peopled by Germans, descended from the natives of Austria proper. The Magyars are Asiatics of the Mongolian race. The South Slavonians occupy the most southern part of the empire, along the low-lying lands of the Danube, which accounts for the small size of their brains; while the Italians are descended from the inhabitants of a still warmer region; all which goes to confirm the theory we have already announced, that the smallest brains belong to the warmest climates. "On comparing the peoples of the four families represented here," continues Dr. Wiesbach, "we find that the Slavonic family possess the largest encephalon, the Romanic the smallest; and that the intermediate Magyars possess a more weighty encephalon than the Germans, which are nearly equal to the Romanic stock."

In a recently-published work Professor Bischoff, an eminent anatomist at Munich, gives the average brain-weight of males as forty-eight ounces ("Nature," January 20, 1881) after weighing five hundred and fifty-nine subjects, the obvious reason for the discrepancy between him and the authors above mentioned being the fact that Munich, situated in the southern part of Germany, is warmer than either Edinburgh or New York.

Dr. Tiedemann, of Heidelberg, on the Alpine plateau of the Rhine in Germany, where it is far colder than Edinburgh in winter, gave the average male brain-weight, for the whole of life above puberty, as 53·25 ounces. Sir W. Hamilton, of Edinburgh, estimated the average adult brain, without distinction of health or disease, at 48·25 ounces, for the whole of life. In London, Dr. Sims found it 46·25 ounces. Luschka gives 50·2 ounces as the average weight of a man's brain; Krause makes it 55·4 ounces, according to an article in the "Morning Herald," Sydney, Australia.

The above averages differ, from several causes. Dr. Tiedemann's observations were limited to fifty-two subjects, and included both sexes, but excluded negroes and very aged persons. Sir W. Hamilton had sixty or seventy of both sexes; Dr. Sims, two hundred and twenty; and Dr. Clendinning still more than Dr. Sims, whose patients were largely among the aged, and those afflicted with long-standing disease. Dr. Clendinning, in the Croonian Lectures, gives the following brain-weights from male subjects, which show that the male encephalon loses more than an ounce every ten years after it is fully grown:

| | |
|---|---|
| 15 to 30 years | 50·75 oz. |
| 30 to 50 " | 49·66 oz. |
| 50 to 70 " | 47·1 oz. |
| 70 to 100 " | 41·5 oz. |

Several other eminent anatomists have made similar exhibits—brain-weight decreasing as the intellectual power increases. It is logical, therefore, to conclude that no parallel exists between power of mind and weight of brain.

M. Nikiforoff, a Russian scientist, in an article in the "Novosti," on the weight of brains, expresses his conviction that the weight of the encephalon has no influence whatever on the mental faculties. But, indeed, any reflecting person who has studied the brain-weights of eminent men as compared with ordinary intelligences must arrive at the same conclusion—that a great mind may belong to a person who carries a very small, a medium-sized, or a very large brain, the size and weight neither adding to the mental power nor detracting from it, provided only that the encephalon is sufficient to give due support to the bodily life. And this leads us to note the relation of the size of the brain to the size of the body of which it forms a part.

The following table is taken from the second volume of the "Science and Practice of Medicine" (London, 1868). Its object is to show the weight of the brain relatively to the weight and height of the body at various ages and in both sexes:

| AGE. | Sex. | Weight of body. | | Height of body. | Weight of brain. |
|---|---|---|---|---|---|
| | | Lbs. | oz. | Inches. | Ounces. |
| 1–2... | Male. | 14 | 6 | 28·5 | 33·25 |
| | Female. | 13 | 2 | 27·7 | 29·80 |
| 2–4... | Male. | 20 | 0 | 31·6 | 38·71 |
| | Female. | 18 | 7 | 31·6 | 34·97 |
| 4–7... | Male. | 25 | 8 | 37·5 | 40·23 |
| | Female. | 24 | 9 | 37·0 | 40·11 |
| 7–14... | Male. | 42 | 6 | 47·0 | 45·96 |
| | Female. | 38 | 6 | 45·0 | 40·78 |
| 14–20... | Male. | 68 | 0 | 60·5 | 48·54 |
| | Female. | 63 | 14 | 57·7 | 43·94 |
| 20–30... | Male. | 92 | 14 | 66·75 | 47·90 |
| | Female. | 86 | 13 | 62·0 | 43·70 |
| 30–40... | Male. | 98 | 3 | 66·5 | 48·20 |
| | Female. | 87 | 0 | 62·0 | 43·09 |
| 40–50... | Male. | 102 | 0 | 66·8 | 47·75 |
| | Female. | 84 | 9 | 62·0 | 42·81 |
| 50–60... | Male. | 102 | 0 | 66·0 | 47·44 |
| | Female. | 86 | 0 | 62·0 | 43·12 |
| 60–70... | Male. | 103 | 13 | 65·7 | 46·40 |
| | Female. | 86 | 14 | 61·5 | 42·69 |
| 70–80... | Male. | 106 | 13 | 65·7 | 45·50 |
| | Female. | 80 | 4 | 61·0 | 41·27 |
| 80–90... | Male. | 99 | 0 | 66·7 | 45·34 |
| | Female. | 79 | 0 | 60·0 | 39·77 |

The above table, made by Dr. Boyd from sixteen hundred and seven post-mortem examinations of sane persons, shows that the human brain reaches its maximum of weight in proportion to the rest of the body between the ages of fourteen and twenty in both sexes; and then it continues to decrease through life. While intelligence is rapidly increasing from twenty to sixty years of age, the brain is diminishing. The time that a man knows most is from seventy to eighty; but then his brain is smaller than when he was a boy between seven and fourteen, the age when he thought he knew the most.

Dr. Paul Broca gave the following table of average brain-weights:

| | | | |
|---|---|---|---|
| From 1 to 10 years, | 985·15 | grammes | (34·7 oz.). |
| From 11 to 20 years, | 1,465·27 | " | (51·68 oz.). |
| From 21 to 30 years, | 1,341·53 | " | (47·67 oz.). |
| From 31 to 40 years, | 1,410·36 | " | (49·74 oz.). |
| From 41 to 50 years, | 1,391·41 | " | (49·07 oz.). |
| From 51 to 60 years, | 1,341·19 | " | (47·30 oz.). |
| 61 and upward, | 1,326·21 | " | (46·77 oz.). |

By looking over Dr. Boyd's table it will be seen that heavy brains generally belong to tall men; and so, by our table of individuals, it appears that the heaviest is that of Turgeneff, who was a man of large size, while the lighter brains accompanied men of medium or short stature. Women are generally shorter than men, and their brains relatively smaller. Quatrefages says: "We have known for several years that the stature has an influence upon the weight of the brain. It can not be without influence upon the cavity by which the latter is inclosed. Under similar circumstances in other respects, the weight of the brain varies proportionately, or almost proportionately, to the height."

If we accept the above statement that the largest healthy brains are found in the tallest persons, and add to it the phrenological rule that brain-size is a true measure of mental power, it will follow that giants have the greatest minds in the world, which is contradicted by every day's experience. Dr. Ireland, in his work on idiocy and imbecility, mentions two cretins, each six feet high; several idiot Calibans, six feet six inches; several idiots described by Lomboso, one of whom was eight and a half feet, another seven feet eight inches, with a sister the same height. Large stature may be a general indication of large brain-weight, but the latter can not be taken as a safe index of high intellectual power.

# EARTHQUAKES.

By Professor G. H. DARWIN, F. R. S.

THE earthquake-shocks which have recently occurred in America and Greece, and the great volcanic eruption in New Zealand, have served to keep the subject vividly before us during many months past, and have perhaps created in some alarmist minds an ungrounded expectation that the earth is about to enter on a new period of Plutonic activity. It is natural, then, to ask at the present time what is an earthquake, and what are its causes. Notwithstanding the necessary incompleteness in the answers which can be given to these questions, yet a good deal more is known than appears to be the common property of newspaper writers. The object, then, of the present article is to give a rough sketch of the present state of knowledge in this complicated subject.

Although history abounds with more or less complete accounts of earthquakes, it is remarkable that hardly ten years have yet elapsed since an accurate record was first obtained of what actually occurs during an earthquake. The combination of circumstances is curious, by which a knot of Scotch students, working in Japan, has secured so considerable an advance in seismology. The incessant but usually non-destructive earthquakes by which Japan is visited, the strange Japanese *renaissance*, and the importation of foreign professors, thoroughly trained at the Scotch universities in an accurate perception of mechanical principles, are the three factors which have co-operated to bring about this result.

The Scoto-Japanese professors, of whom the most eminent are Ewing, Gray, and Milne, have studied their subject with admirable persistence, and have by their ingenuity placed seismologists in possession of instruments by which the motion of the ground during an earthquake is recorded on an accurate scale of time. Such instruments are called seismographs, or recording seismometers. During an earthquake the ground and all that is fixed to it move together, and at first sight it seems impossible to get anything to stay still during the vibration. An exact description of a scientific instrument would be out of place here, but a general notion of these seismographs may be easily grasped.

The horizontal pendulum of Zöllner, and a suggestion of Chaplin (also a professor in Japan), are the sources from which "the horizontal pendulum seismograph" of Ewing originated. The principles according to which it is constructed may be explained as follows: If we consider an open door which can swing on its hinges, and imagine that a sudden horizontal movement is given to the door-post, at right angles to the position in which the door is hanging, then it is clear that the outer edge of the door will begin to move with a sort of recoil in the direction opposite to that of the movement imparted to the door-post. Since the door-post moves in one direction, while the edge of the door recoils, somewhere in the door there is a vertical line which remains still. The exact position of this line depends on the proportion which the amount of the recoil of the outer edge bears to the direct motion of the door-post. Now, if the sudden movement is imparted to the door-post by means of the floor to which it is attached, it is clear that a pencil attached to the door at this vertical line will write on the floor the displacement of the door-post, notwithstanding that the floor has moved. If next we suppose that there are two such doors hanging at right angles to one another from the same door-post, and that a sudden horizontal movement *in any direction* is given to the floor, each pencil will write on the floor that part of the movement which was at right angles to its door. Lastly, if the floor or surface on which the record is written is kept moving uniformly by clock-work, we obtain also a register in time as well as space.

But in an earthquake the surface of the earth undergoes also a vertical movement which has to be recorded. The principle by which an instrument may be constructed to attain this end is as follows: If a weight hangs by a long, elastic cord, so that when set dancing up and down it oscillates very slowly, then, when a sudden jerk is given to the point of support, the weight will for the moment stand almost stationary, and a pencil attached to it may write its record on a surface fastened to the part jerked. This idea has been utilized in the construction of a vertical seismograph, but various important modifications have been introduced for the purpose of annulling the spontaneous dance of the weight after the shock has occurred.*

It will undoubtedly serve to give an impulse to this science that henceforth the intending observer need not waste time in devising and constructing instruments, but can purchase the complete equipment of a seismological observatory, as recommended by Ewing, and may begin work at once.

Many other instruments besides these have been used for the observation of earthquakes, and among the best are those of Bertelli, Rossi, and Palmieri. An instrument which tells only that there has been a shock, without giving a record of the nature of the movement, is called a seismoscope. Some of the Italian instruments are seismoscopes, which, however, give an approximate idea of the severity and direction of the vibration, and others claim to be accurate seismographs or seismometers. But I do not think that any of them can compete with the instruments described in outline above.

And what do recording instruments tell us of the actual occurrences during an earthquake?

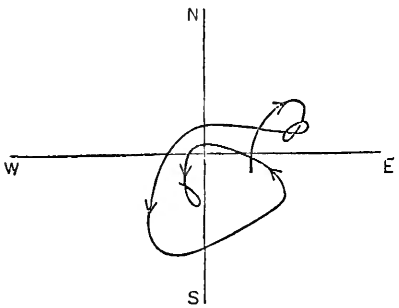
"They show," writes Ewing,† "that, as observed at a station on the surface of the earth, an earthquake consists of a very large number of successive vibrations—in some cases as many as three hundred have been distinctly registered. They are irregular both in period and amplitude, and the amplitude does not exceed a few millimetres" (a millimetre is one twenty-fifth of an inch), "even when the earthquake is of sufficient severity to throw down chimneys and crack walls, while in many instances the greatest motion is no more than the fraction of a millimetre. The periods of the principal motions are usually from half a second to a second, but . . . the early part of the disturbance often contains vibrations of much greater frequency. The earthquake generally begins and always ends very gradually, and it is a

* I make no attempt to apportion the credit among the several inventors of these instruments. The men mentioned have played the leading parts, and the work of all seems to be thorough and sound.

† "Memoirs of the Science Department of the University of Tokio," No. 9, 1883, p. 13.

noteworthy fact that there is in general no one motion standing out from the rest as greatly larger than those which precede and follow it. The direction of motion varies irregularly during the disturbance—so much so, that in a protracted shock the horizontal movements at a single station occur in all possible azimuths" (that is to say, to all points of the compass). "The duration, that is to say the time, during which the shaking lasts at any one point is rarely less than one minute, often two or three, and in one case in the writer's experience was as much as twelve minutes."

The horizontal path pursued, in an actual earthquake at Tokio, on March 8, 1881, by the part of the recording instrument which was fixed to the ground, is shown in the annexed figure.* It is magnified six fold, and the time occupied from the beginning to the end of this part of the vibration was three seconds. This earthquake, although alarming, did no damage except to crack a few walls.




It is obvious that when the motion is so complicated, the impressions of people present go for little as compared with an automatic record. Observers often differ widely among themselves as to what was the direction of the prevailing oscillation, and the magnitude of the displacement of the ground is generally much exaggerated. It is true that in some of the great historic earthquakes the displacements are supposed to have been considerable; for example, according to Mallet, in the Neapolitan shock of 1857 it amounted to a foot, and Abella assigns six feet as the amplitude in the Manila earthquake of 1881. But, without contesting the accuracy of these estimates, it is safe to say that such displacements are very rare, for, as proved by automatic seismographs, when the motion is as much as a quarter of an inch, brick and stone chimneys are generally shattered.

Every railway-traveler knows that it is not the steady speed, but the starting and stopping, which jars him; that is to say, it is change of velocity by which he is shaken. The misconception of an observer in an earthquake arises from the fact that the sensation of being tossed about comes from the change of velocity to which he is subjected, rather than from the extent of his displacement. Now, the greatest change per second of velocity may be considerable in a vibration, while the amplitude is small.

The force of gravity is the most familiar example of a change per second of velocity, for in each second the velocity of a falling body is augmented by a velocity of thirty-two feet a second. Ewing appears

† "Memoirs of the Science Department of the University of Tokio," No. 9, 1883, p. 58.

to have been the first to think of comparing the greatest change per second of velocity in an earthquake with gravity. Thus at Tokio, on March 11, 1882, walls were cracked and chimneys knocked over, and in this shock the greatest change per second of velocity may be expressed by the phrase one thirty-fifth of gravity; in other words, the greatest change per second of velocity was $\frac{32}{35}$ of a foot per second. This conclusion enables us also to illustrate the mechanical consequences of the shock in another way; for if a wall thirty-five feet high leans over, so that the top brick projects a foot beyond the bottom brick, the forces tending to upset the wall are the same as those which occurred in this earthquake.

No great shock has ever yet been recorded by automatic instruments, and it is not unlikely that in these great disasters the instruments would be thrown out of gear, and no record would be obtained. Thus, earthquakes which only work a moderate amount of destruction are the most favorable for scientific operation.

Since the oscillations at any one spot are usually in all sorts of directions, it is impossible, from observation at a single place, to form a sound opinion as to position of the origin of the disturbance. Much information useful for the study of vibrations and of the laws of their decrease with increasing distance, has resulted from a laborious series of experiments made by Milne at Tokio. Artificial earthquakes were produced by the explosion of gun-cotton in holes in the ground, and by the fall of heavy weights, and the records at various distances from the origin were obtained.

From theoretical considerations, confirmed by these experiments, it is established that earthquake-waves consist of oscillations of two kinds, namely, waves or vibrations of compression, and of distortion. In the first kind the motion of each particle of the ground is to and fro in the direction in which the wave is traveling; and in the second kind the excursions are at right angles to the direction of wave-propagation. As the former vibrations travel more rapidly than the latter, all the compressional waves may have passed a given station before the arrival of the distortional waves, and thus the shock may be apparently duplicated. Or, nearer to the origin, the two series will overlap, and a complex movement ensues, such as that exhibited in the figure above. The phenomena are further complicated by frequent reflections and refractions, as the wave passes from one geological stratum to another. The rate at which these waves travel depends on the nature of the rock through which the movement passes; velocities ranging from a mile per second to five miles per second are usual.

The destructive effects of earthquakes on buildings are notorious, and it is unnecessary to describe them here. By an examination of ruined buildings a competent observer is often able to obtain a good deal of information as to the nature of the shock. Thus Mallet visited the towns destroyed by the Neapolitan earthquake of 1857, and, by a very careful consideration of the fractures in walls and other damage, was able to draw a number of interesting conclusions as to the directions and amplitudes of the principal vibrations and as to the site of the center of disturbance.

Architects should be able, by an adherence to sound mechanical principles, to construct buildings which should stand against all but the severest shocks, and much has already been done in this way. Where a choice for the site of an intended building is possible, the most important consideration is that it should be where there has been the greatest immunity from vibration on previous occasions, for, even within a very small area, different spots are very differently affected. In most regions there is only a single important center whence earthquakes originate, and the safe places are situated in what may be called earthquake-shadow for the prevalent vibrations. For just as a high wall, a hill, or a railway-cutting often completely cuts off sounds by forming a sound-shadow, so a ravine or some arrangement of the geological formation may afford earthquake-shadow for particular places.

It is not in general possible to pick out the favorable sites by mere inspection, for the distribution of vibration is often apparently capricious. Thus Milne tells us of a princely mansion at Tokio "which has so great a reputation for the severity of the shakings it receives, that its marketable value has been considerably depreciated, and it is now untenanted."*

In a town which is frequently shaken there is no need to wait long to carry out a rough survey with seismographs, and thus to obtain an idea of the relative shakiness of the various parts. If such a survey is impossible, it is best to avoid as the site for building a loose soil, such as gravel, resting on harder strata, and the edge of a scarp or bluff, or the foot of similar eminences.†

The same capriciousness of distribution, which is observable on a small scale, is found to hold on a large scale when we consider the distribution of earthquakes throughout a whole country. Regions subject to earthquakes, or seismic areas, appear to have fairly definite boundaries, which remain constant for long periods. For example, in Japan, earthquakes are rarely felt on the western side of the central range of mountains.

The search for the actual point whence the earthquake originated is one of the most interesting branches of the science. In order to trace the earthquakes in a country to their origin, the places of observation should not be chosen where there is comparative immunity from shaking. Thus a seismic survey is necessary, and the limits of the seismic areas will be discovered in the course of it. Milne commenced his survey of Japan by sending to the local government offices in the important towns, distant from thirty to a hundred miles from Tokio, packets

* Milne, "Earthquakes," p. 134.

† Ibid., p. 144.

of post-cards, one of which was to be returned to him at the end of each week with a record of the shocks which had been felt. "The barricade of post-cards was then extended farther northward, with the result of surrounding the origin of certain shocks among the mountains, while others were traced to the sea-shore. By systematically pursuing earthquakes, it was seen that many shocks had their origin beneath the sea, . . . but it was seldom that they crossed through the mountains forming the backbone of the island."* When the country had been thus mapped out, it was possible to choose the most advantageous sites for the observatories.

It would carry us too far into technical matters to describe the method of searching into the bowels of the earth for the actual point of disturbance. It must here suffice to say that if a shock be accurately timed at various places, and if the approximately circular ring where it was most severe be determined, it is possible to find with fair accuracy the spot or spots under which it originated and the depth of the earthquake-center. Even without accurate time-observations, Mallet was able to show that the Neapolitan shock originated between three and seven miles below the surface. The Yokohama earthquake of 1880 appears to have had its center at a depth of from one and a half to five miles. Notwithstanding that one earthquake has been estimated as originating at a depth of fifty miles, it is probable that in all cases the center of shock is only a few miles below the surface.

The vagueness as to the position which has been assigned for the center of disturbance in the case of particular earthquakes probably depends less on the difficulty of tracing back the vibrations to their origin, than on the fact that the shocks do not usually originate in a single point, but rather along a line of a mile or two in length.

As to the way in which seismic activity is distributed geographically over the earth's surface, certain broad conclusions have been fairly well ascertained. If a map be shaded, so as to represent the frequency of earthquakes, we see that the shading has a tendency to fall into bands or ribbons, which generally follow the steeply sloping shores of continents and islands; and it is probable that the actual origins of the shocks are generally situated under the sea not far from the coast.

It is a further interesting peculiarity that the most important bands fall end to end, so that they may be regarded as a single ribbon embracing nearly half the earth. It may be suspected that this ribbon really meets itself and forms a closed curve, but this can not be proved as yet. We may begin to trace its course at Cape Horn, whence it follows the Andes along the whole western coast of South America. At the north of that continent it becomes somewhat broader, but its course is clearly marked along the line of the West Indies from Trinidad to Cuba. Hence it passes to the mainland in Mexico, and then runs along the whole western coast of North America. We then trace the line

* Milne, "Earthquakes," p. 189.

through the Aleutian Islands to Kamchatka, and thence southward through the Japanese Islands, the Philippines, and the Moluccas, to Sumatra and Java. Another branch seems to run from Sumatra, through New Guinea, to New Zealand, and the closed curve may perhaps be completed through the Antarctic regions, which are known to be volcanic. Returning to the first branch which we traced as far as Java, to the westward the seismic areas become more patchy and less linear. It may, however, perhaps be maintained that the ribbon runs on through India, Persia, Syria, the Eastern Mediterranean, Greece, and Italy.

This grouping of seismic areas into a ribbon does not comprise all the regions of earthquakes, but it must rather be taken as meaning that there is one great principal line of cracking of the earth's surface. In speaking here of earthquakes, those sensible shocks are meant which are sufficiently severe to damage buildings, for, as will be explained below, there is reason to believe that the whole earth is in a continual state of tremor.

Seismic areas are not absolutely constant in their limits, and cases are known where regions previously quiescent have become disturbed. It seems likely that the recent disastrous earthquake at Charleston belongs to the West Indian system of seismic activity, but there is no reason to suspect a permanent extension of the West Indian area so as to embrace the Southern States. On the contrary, it is far more probable that this disastrous shock will remain a unique occurrence. The previous experience of great earthquakes, such as that of Lisbon in the middle of the last century, shows, however, that the inhabitants of Charleston must for the next year or two expect the recurrence of slight shocks, and that the subterranean forces will then lull themselves to sleep again.

With regard to the distribution of earthquakes in time there is no evidence of either decrease or increase within historical periods, and although physical considerations would lead us to suppose that they were more frequent in early geological times, geology at least can furnish no proof that this has been the case.*

A great deal has been written on the causes of earthquakes, and many of the suggested theories seem fanciful in the highest degree. It is clear, however, that the primary cause resides in the upper layers of the earth, and that the motive power is either directly or indirectly the internal heat of the earth. The high temperature of the rocks, in those little scratches in the earth's surface which we call mines, proves the existence of abundant energy for the production of any amount of disturbance of the upper layers. It only remains to consider how that energy can be brought to bear. One way is by the slow shrinking of the earth, consequent on its slow cooling. Now, the heterogeneity of the upper layers makes it impossible that the shrinkage shall occur

* Geikie, "Contemporary Review," October, 1886.

with perfect uniformity all round. Thus, one part of the surface will go down before another, and as this must usually occur by a cracking and sudden motion, the result will be an earthquake.

The seismic ribbons of which we have spoken are probably lines of weakness along which cracking habitually takes place. Along these lines there are enormous dislocations of the geological strata, and earthquakes are known to follow lines of faulting. The geologically recent elevation of the Pacific coast of South America is obviously, from this point of view, connected with the abundance of volcanoes and the frequency of earthquakes along the chain of the Andes.

One would think that the continual ejection of lava and ashes from an active volcano must leave a hollow under the mountain, and that some day the cavern would suddenly collapse. It has, however, been observed that volcanic eruptions and severe earthquakes are to some extent alternatives, so that it seems as though the volcanic vent served as a safety-valve for the liberation of the dangerous matter. But the theory of the collapsing cavern must not be wholly rejected, for some disastrous earthquakes affecting only very restricted areas, such as that of Casamicciola in Ischia, are hardly otherwise explicable. In this case Palmieri has attributed the formation of the cavern to evisceration under the town produced by hot mineral springs.

In the theories of which we have just spoken, the internal heat of the earth acts indirectly, by giving to gravitation an opportunity of coming into play. But as in volcanic eruptions enormous quantities of steam are usually emitted, it is probable that the pressure of steam is the force by which the lava and ashes are vomited forth, and that the steam is generated when water has got among hot internal rocks. From this point of view we can understand that an eruption will serve as a protection against earthquakes, and that the centers of disturbance will usually be submarine.

It may on the whole be safely concluded that a diversity of causes are operative, and that some earthquakes are due to one and others to other causes.

It would, however, be certainly wrong to look only to the interior of the earth for the causation of earthquakes, since the statistics of earthquakes clearly point to connections with processes external to the solid earth.

The laborious inquiries of M. Perrey show that there are more earthquakes at the time of full and change of moon than at other times, more when the moon is nearest to the earth and more when she is on the meridian than at the times and seasons when she is not in those positions relatively to the earth. The excess of earthquakes at these times is, however, not great, and an independent investigation of the Japanese earthquakes does not confirm Perrey's results. It is well, therefore, still to hold opinion in suspense on this point. If, however, Perrey's result should be confirmed, we must attribute it to the action of those forces which produce tides in the ocean, and therefore at the same time cause a state of stress in the solid earth.

Then again it is found that earthquakes are indubitably more apt to occur when there is a rapid variation of the pressure of the air, indicated by a rise or fall of the barometer, than in times of barometric quiescence. It is certain that earthquakes in both hemispheres are more frequent in the winter than in the summer ; this is probably connected with the greater frequency of sudden rises and falls of the barometer at that season. It may, however, be urged against this view that volcanic eruptions are somewhat more frequent in the summer. But whatever be the action of these external processes with regard to earthquakes, it is certain that the connection between the two is merely that of the trigger to the gun. The internal energy stands waiting for its opportunity, and the attraction of the moon or the variation in atmospheric pressure pulls the trigger. Thus the predictions of disaster which have frequently been made for particular dates must be regarded as futile.

It has long been known that an earthquake is preluded by slight tremors leading by a gradual *crescendo* to the destructive shocks. But within the last fifteen years it has been discovered that the earth's surface is being continually shaken by tremors, so minute as to remain unsuspected without the intervention of the most delicate instruments. In every country where the experiment has been tried, these tremors have been detected, and not merely at certain periods, but so incessantly that there is never a second of perfect rest. The earth may fairly be said to tremble like a jelly. The pioneer in this curious discovery was Father Bertelli. His experiments relate only to Italy, but that which has been found true also of England, France, Egypt, Japan, Brazil, and a solitary island in the South Pacific Ocean, probably holds good generally, and we may feel sure that earth-tremors or "microseisms" are not confined to countries habitually visited by the grosser sort of earthquakes.

Almost all our systematic knowledge of microseisms comes from Italy, for a co-operation has been arranged there between many observers with ingenious instruments at their disposal. Besides Bertelli, the most eminent of the observers is Cavaliere Michele de Rossi, who has established at Rome a "Geodynamical Observatory," and has initiated as an organ of publication the "Bulletino del Vulcanismo Italiano," in whose pages are to be found contributions from Malvasia, Monte, Cecchi, Palmieri, Egidi, Galli, and many others. The literature which has already accumulated on the subject is extensive, and it will only be possible generally to indicate its scope.

The Italians have, of course, occupied themselves largely with earthquakes, but in that field their results do not present a great deal that is novel. The instruments in use for the observation of microseisms are scarcely to be classed as perfect seismographs or seismometers, and the minuteness of the movements to be observed no doubt entails especial difficulties. The "normal tromometer" of Bertelli and Rossi is a simple pendulum, about six feet long, with an arrangement for observing the dance of the pendulum-bob with a microscope. With this and other instruments it has been established that the soil of Italy trembles incessantly. The agitation of the pendulum is usually relatively considerable for about ten days at a time ; toward the middle of the period it increases in intensity, when there generally ensues an earthquake which can be perceived without instruments ; the agitation then subsides. This has been called by Rossi a seismic period or seismic storm. After such a storm there ensues a period of a few days of relative quiescence.

The vibration of the pendulum in these storms is in general parallel to neighboring valleys or chains of mountains, and its intensity seems to be independent of wind, rain, and temperature. Care is of course taken not to mistake the tremors due to carts and carriages for microseismic agitation, and it has been found easy to effect this separation. The positions of the sun and moon exercise some influence on these tremors, but the most important concomitance which has been established is that they are especially apt to be intense when the barometer is low.

Microseismic storms are not strictly simultaneous at different places in Italy ; but if a curve be constructed to represent the average intensity of agitation during each month, it is found on comparison of the curves for a year—for, say, Rome, Florence, and Leghorn—that there is a very close agreement between them.

Rossi has also made some interesting experiments with the microphone on microseisms. In this instrument one electrical conductor is arranged to rest on another at a single point—say, a nail resting on its point on a shilling. One copper wire is attached to the nail and another to the shilling, and an electric current, with an ordinary telephone receiver in the circuit, is then passed through the system. As long as the microphone is still, nothing is heard ; but on the occurrence of the very slightest tremor, a noise is audible in the telephone. The instrument can be made so sensitive that a fly may be heard to walk near the microphone with a loud tramp, and a touch with a hair to the nail or to the shilling would sound like the grating of a harsh saw.

Rossi placed his microphone on the ground in a cavern sixty feet below the surface, on a lonely part of Rocca di Papa, an extinct volcano not far from Rome, while he listened with his telephone at the surface of the earth. He then heard the most extraordinary noises, which, as he says, revealed "natural telluric phenomena."

The sounds he describes as "roarings, explosions occurring isolated or in volleys, and metallic or bell-like sounds." They all occurred mixed together, and rose and fell in intensity at irregular intervals. He found it impossible by any artificial disturbance to a microphone to produce the greater number of these noises. The microphone is especially sensitive to vertical movements of the soil, whereas the tromometer fails to reveal them. Nevertheless, there was more or less concordance between the agitations of the two instruments. In order, then, to determine the noises corresponding to various kinds of oscillation, he transported his microphone to Palmieri's Vesuvian observatory, where mild earthquakes are almost incessant; here he discovered that each class of shock had its characteristic noise. The vertical shocks gave the volleys of musketry and the undulatory shocks the roarings. By a survey with his microphone he concluded that the mountain is divided by lines of approximate stillness into regions where the agitation is great. If a metal plate dusted over with sand is set into vibration by a violin-bow rubbing on its edge, all the sand congregates into lines which mark out a pattern on the plate: these lines are nodes, or lines of stillness. It appears, then, that, when Vesuvius trembles with earthquake-shocks, its method of vibration is such that there are nodes of stillness.

At the Solfatara of Pozzuoli the sounds were extraordinarily loud; and the prevailing noise could be imitated by placing the microphone on the lid of a boiling kettle. Similar experiments have since been made by Milne in Japan with similar results.

Some years ago my brother Horace and I made some experiments at Cambridge with a pendulum, so arranged as to betray the minutest displacements. It was then but few years since Bertelli and Rossi had begun to observe; we had read no account of their work, and earth-tremors were quite unsuspected by us. Indeed, the object of our experiment, the measurement of the moon's attraction on a plummet, was altogether frustrated by these disturbances. The pendulum was successfully shielded from the shaking caused by traffic in the town, so that there was no perceptible difference in its behavior in the middle of the night on Sunday, and in the day-time during the week. We were then much surprised to find that the dance of the pendulum (for it was not a regular oscillation) was absolutely incessant. The agitation was more marked at some times than at others; the relatively large swinging, though absolutely very small, would continue for many days together, and this would be succeeded by a few days of comparative calm. In fact, we saw the seismic storms and calm of the Italians.* As the instrument was designed for another purpose, and was not quite appropriate for microseismic observation, we did not continue to note it after a month or two. But the substantial identity of the microseisms of England and Italy seems fairly well established.

The cause of these interesting vibrations are as yet but little understood, and it may be hoped that the subject will receive further attention. It seems probable that they are in part true microscopic earthquakes, produced by the seismic forces in the neighborhood.

* "Report to the British Association on the Lunar Disturbances of Gravity," 1881.

But they are also doubtless due to the reverberation of very distant shocks. It is probable that there is not a minute of time without its earthquake somewhere, and the vibrations may often be transmitted to very great distances. In only a very few cases has it hitherto been possible to identify a tremor with a distant shock, and even then the identification is necessarily rather doubtful. One of the best authenticated of these cases was when M. Nyrèn, an astronomer at St. Petersburg, noticed on May 10 (April 28), 1877, a very abnormal agitation of the levels of his telescope, an hour and fourteen minutes after there had been a very severe shock at Iquique, in Peru.

Astronomers are much troubled by slight changes in the level of the piers of their instruments, and they meet this inconvenience by continually reading their levels and correcting their results accordingly. Of course, they also take average results. These troublesome changes are probably earth-tremors, with so slow a motion to and fro that the term tremor becomes inappropriate. This kind of change has been called a displacement of the vertical, since a plummet moves relatively to the ground. Thus, we found at Cambridge that as the pendulum danced it slowly drifted in one direction or the other. There was a fairly regular daily oscillation, but the pendulum would sometimes reverse its expected course for a few minutes, or for an hour. During the whole time that we were observing, the mean position of the pendulum for the day slowly shifted in one direction ; but even after a voyage of six weeks the total change was still excessively small. How far this was a purely local effect and how far general we had no means of determining.

This is a subject which M. d'Abbadie, of the French Institute, has made especially his own. Notwithstanding his systematic observations, carried on during many years in an observatory near the Bay of Biscay, on the French side of the Spanish frontier, hardly anything has been made out as to the laws governing displacements of the vertical. He has, however, been able to show that there is a tendency for deflection of the vertical toward the sea at high tide, but this deflection is frequently masked by other simultaneous changes of unexplained origin.

This result, and the connection between barometric variations and earthquakes and tremors, should make us reflect on the forces which are brought into play by the rise and fall of the tide and of atmospheric pressure. Our very familiarity with these changes may easily blind us to the greatness of the forces which are so produced. The sea rests on the ground, and when the tide is high there is a greater weight to be supported than when it is low. A cubic foot of water weighs 62 pounds ; thus if high-tide be only ten feet higher than low-tide, every square foot of the sea-bottom supports 620 pounds more at high than at low water ; and 620 pounds to the square foot is nearly 8,000,000 tons to the square mile. Again, the barometer ranges through fully two inches, and a pool of mercury two inches deep and a square foot in area weighs 145 pounds; hence, when the barometer is very high, every square foot of the earth-surface supports about 140 pounds more than if it is low; and 140 pounds to the square foot is 1,800,000 tons to the square mile.

Now, rocks are not absolutely rigid against flexure, certainly less so than most of the metals, and these enormous weights have to be supported by the rocks. Taking a probable estimate for the elasticity of rocks, I have made some calculations as to the amount of effect that we may expect from this shifting of weights, and I find that it is likely that we are at least three or four inches nearer the earth's center when the barometer is very high than when it is very low.*

It may be that the incessant straining and unstraining of the earth's surface is partly the cause of earth-tremors, and we can at least understand that these strains may well play the part of the trigger for precipitating the explosion of the internal seismic forces. The calculations also show that near the sea-coast the soil must be tilted toward the sea at high-water, and that the angle of tilting may be such as could be detected by a delicate instrument like that of M. d'Abbadie.

This breathing of the solid earth seems to afford a wide field for scientific activity. It would be premature to speculate as to how far it will be possible to educe law from what is now chaotic; but it is clear that the co-operation of many observers will be required to separate the purely local from the true terrestrial changes. The directors of astronomical observatories have peculiar facilities for the study of displacements of the vertical, and it is to be regretted that hitherto most of them have been contented to banish, as far as may be, the troubles caused in their astronomical work by earth-tremors and displacements of the vertical.—*Fortnightly Review.*

* "Second Report to the British Association on Lunar Disturbances of Gravity," 1882.

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Professor Judd, in his address at the last annual meeting of the Geological Society, showed that minerals are subject to physiological changes, analogous to those which take place in plants and animals, though differing in the form of their manifestation and the time they occupy. They have a life-history, he says, "which is in part determined by their original constitution, and in part by the long series of slowly-varying conditions to which they have since been subjected. In spite of the circumstance that their cycles of change have extended over periods measured by millions of years, the nature of their metamorphoses and the processes by which these have been brought about are, in all essential respects, analogous to those which take place in a sequoia or a butterfly." By this, he does not mean that minerals actually live, in the sense in which "living" is popularly understood; but that, like animals and plants, they go through definite cycles of change, dependent on their environment. Hence the distinction between "organic" or "living" matter, and "inorganic" or "lifeless" matter, is not fundamental.

# NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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## II.—METEOROLOGY.*

THE popular beliefs of classic antiquity regarding storms, thunder, and lightning, took shape in myths representing Vulcan as forging thunderbolts, Jupiter as flinging them at his enemies, Æolus intrusting the winds in a bag to Æneas, and the like. An attempt at their further theological development is seen in the Pythagorean statement that lightnings are intended to terrify the damned in Tartarus.

But, at a very early period, we see the beginning of a scientific view. In Greece, the Ionic philosophers held that such phenomena are obedient to law; Plato, Aristotle, and many lesser lights, attempted to account for them on natural grounds; and their explanations, though crude, were based upon observation and thought. In Rome, Lucretius, Seneca, Pliny, and others, inadequate as their statements were, implanted at least the germs of a science. But, as the Christian Church rose to power, this evolution was checked; the new leaders of thought found, in the Scriptures recognized by them as sacred, the basis for a new view, or rather for a modification of the old view.

This ending of a scientific evolution based upon observation and reason, and this beginning of a sacred science based upon the letter of Scripture and on theology, are seen in the utterances of various Fathers in the early Church. As to the general features of this new development, Tertullian held that sundry passages of Scripture prove lightning identical with hell-fire; † and this idea was transmitted from generation to generation of later churchmen, who found an especial support of Tertullian's view in the sulphurous smell experienced during thunderstorms.‡ Saint Hilarion thought the firmament very much lower than the heavens, and that it was created for the support of the upper waters, as well as for the tempering of our atmosphere.# Saint Ambrose held the firmament to be a solid vault, and the thunder to be caused by the winds breaking through it; citing from the prophet Amos the sublime passage regarding "Him that establisheth the thunders." ‖ He shows, indeed, some conception of the true source of rain; but his whole reasoning is limited by various scriptural texts. He lays great stress upon the firmament as a solid outer shell of the universe: the heavens he holds to be not far outside this outer shell, and argues regarding their

* See "The Popular Science Monthly" for October, 1885.

† See Tertullian, "Apol. contra gentes," c. 47.

‡ See, for example, Augustin de Angelis, "Lectura Meteorologia," 64.

# See Hilarion, "In Psalm," cxxxv (Migne, "Patr. Lat.," ix, 773).

‖ "Firmans tonitrua" (Amos iv, 13); the phrase does not appear in our version.

character from Saint Paul's Epistle to the Corinthians and from the one hundred and forty-eighth Psalm. As to "the waters which are above the firmament," he takes up the objection of those who hold that, this outside of the universe being spherical, the waters must slide off it, especially if the firmament revolves; and he points out that it is by no means certain that the *outside* of the firmament *is* spherical, and insists that, if it does revolve, the water is just what is needed to lubricate and cool its axis.*

Saint Jerome held that God at the creation spread out the firmament between heaven and earth, separating the upper waters from the lower, and that, in order to keep all in place, He caused the upper waters to be frozen into ice. A proof of this view Jerome found in the words of Ezekiel regarding "the crystal stretched above the cherubim."†

The germinal principle in accordance with which all these theories were evolved, was most clearly proclaimed to the world by Saint Augustine in his famous utterance, "Nothing is to be accepted save on the authority of Scripture, since greater is that authority than all the powers of the human mind."‡ No treatise was safe thereafter which did not breathe the spirit and conform to the letter of this maxim. Unfortunately, what was generally meant by the "authority of Scripture," was the tyranny of a literature imperfectly transcribed, viewed through distorting superstitions, and frequently interpreted by party spirit.

Following this precept, Saint Augustine developed, in every field, theological views of science which have never led to a single truth—which, without exception, have forced mankind away from the truth, and have caused Christendom to stumble for centuries into abysses of error and sorrow. In meteorology, as in every other science with which he dealt, he based everything upon the letter of the sacred text; and it is characteristic of the result that this man, so great when untrammeled, thought it his duty to guard especially the whole theory of the "waters above the heavens."

In the sixth century this theological reasoning was still further developed by Cosmas Indicopleustes. Basing his theory of the universe upon the ninth chapter of Hebrews, he insisted that the earth is flat, a parallelogram, and that from its outer edges rise immense walls

* See Ambrose, "Hexæmeron," ii, 3, 4; iii, 5 (Migne, "Patr. Lat.," xiv, 148–150, 153, 165). The passage as to lubrication of the heavenly axis is as follows: "Deinde cum ipsi dicant volvi orbem cœli stellis ardentibus refulgentem, nonne divina providentia necessario prospexit, ut intra orbem cœli, et supra orbem redundaret aqua, quæ illa ferventis axis incendia temperaret?"

† See Jerome, "Epistola," lxix, 6 (Migne, "Patr. Lat.," xxii, 659).

‡ "Major est quippe Scripturæ hujus auctoritas, quam omnis humani ingenii capacitas."—Augustine, "De Genesi ad Lit.," ii, 5 (Migne, "Patr. Lat.," xxxiv, 266, 267). Or, as he is cited by Vincent of Beauvais ("Spec. Nat.," iv, 98): "Non est aliquid temere diffiniendum, sed quantum Scriptura dicit accipiendum, cujus major est auctoritas quam omnis humani ingenii capacitas."

supporting the firmament; then, throwing together the reference to the firmament in Genesis and the outburst of poetry in the Psalms regarding the "waters that be above the heavens," he insisted that over the terrestrial universe are solid arches bearing a vault, closing it in and supporting a vast cistern "containing the waters"; finally, taking from Genesis the expression regarding the "windows of heaven," he insisted that these windows are opened and closed by the angels whenever the Almighty wishes to send rain upon the earth or to withhold it.*

This was accepted by the universal Church as a vast contribution to thought; for over a thousand years it was the orthodox doctrine, and various leaders in theology devoted themselves to developing and supplementing it.

About the beginning of the seventh century, Isidore, Bishop of Seville, was the ablest prelate in Christendom, and was showing those great qualities which led to his enrollment among the saints of the Church. His theological view of science marks an epoch. As to the "waters above the firmament," Isidore contends that they must be lower than the uppermost heaven, though higher than the lower heaven, because in the one hundred and forty-eighth Psalm they are mentioned *after* the heavenly bodies and the "heaven of heavens," but *before* the terrestrial elements. As to their purpose, he hesitates between those who held that they were stored up there by the prescience of God for the destruction of the world at the flood, as the words of Scripture that "the windows of heaven were opened" seemed to indicate, and those who held that they were kept there to moderate the heat of the heavenly bodies. As to the firmament, he is in doubt whether it envelops the earth "like an egg-shell," or is merely spread over it "like a curtain"; for he holds that the passage in the one hundred and fourth Psalm may be used to support either view.

Having laid these scriptural foundations, Isidore shows considerable power of thought; indeed, at times, when he discusses the rainbow, rain, hail, snow, and frost, his theories are rational, and give evidence that, if he could have broken away from his adhesion to the letter of Scripture, he might have given a vast impulse to the evolution of a true science.†

About a century later appeared, at the other extremity of Europe, the second in the trio of theological men of science in the early middle ages, Bede the Venerable. The nucleus of his theory also is to be found in the accepted view of the "firmament" and of the "waters above the heavens," derived from Genesis; the firmament he holds to be spherical, and of a nature subtile and fiery; the upper heavens, he says, which contain the angels, God has tempered with ice, lest they

* See Cosmas, "Topographia Christiana" (in Montfaucon, "Collectio nova patrum," ii).

† See Isidore, "Etymologiæ," xiii, 7–9, "De ordine creaturarum," 3, 4, and "De natura rerum," 29, 30 (Migne, "Patr. Lat.," lxxxii, 476, 477, lxxxiii, 920–922, 1001–1003).

inflame the lower elements; as to the waters placed above the firmament, lower than the spiritual heavens, but higher than all corporeal creatures, he says, "Some declare that they were stored there for the deluge, but others, more correctly, that they are intended to temper the fire of the stars." He goes on with long discussions as to various elements and forces in Nature, and dwells at length upon the air, of which he says that the upper, serene air is over the heavens; that the other, which is coarse with humid exhalations, is sent off from the earth, and that in this are lightning, hail, snow, ice, and tempests, finding proof of this in the one hundred and forty-eighth Psalm, where these are commanded to "praise the Lord from the earth." *

So great was Bede's authority that nearly all the anonymous speculations of the next following centuries upon these subjects were eventually ascribed to him. In one of these spurious treatises an attempt is made to get new light upon the sources of the waters above the heavens, the main reliance being the sheet containing the animals let down from heaven, in the vision of Saint Peter. Another of these treatises is still more curious, for it endeavors to account for earthquakes and tides by means of the Leviathan mentioned in Scripture. This characteristic passage runs as follows: "Some say that the earth contains the animal Leviathan, and that he holds his tail after a fashion of his own, so that it is sometimes scorched by the sun, whereupon he strives to get hold of the sun, and so the earth is shaken by the motion of his indignation; he drinks in also, at times, such huge masses of the waves that when he belches them forth all the seas feel their effect." † And this theological theory of the tides, as caused by the alternate suction and belching of Leviathan went far and wide.

In the writings thus covered with the name of Bede, there is much showing a scientific spirit, which might have come to something of permanent value had it not been hampered by the supposed necessity of conforming to the letter of Scripture. It is as startling as it is refreshing to hear one of these mediæval theorists burst out against those who are content to explain everything by the power of God, as follows: "What is more pitiable than to say that a thing *is*, because God is able to do it, and not to show any reason why it is so, nor any purpose for which it is so; just as if God did everything that he is able to do! You talk like one who says that God is able to make a calf out of a log. But *did* he ever do it? Either, then, show a reason why a thing is so, or a purpose wherefore it is so, or else cease to declare it so." ‡

* See Bede, "De natura rerum" (Migne, "Patr. Lat.," xc).

† See the treatise "De mundi constitutione," in Bede's "Opera" (Migne, "Patr. Lat.," xc, 884).

‡ See "Elementa philosophiæ," in Bede's "Opera" (Migne, "Patr. Lat.," xc, 1139). This treatise, which has also been printed, under the title of "De philosophia mundi," among the works of Honorius of Autun, is believed by modern scholars (Hauréau, Werner, Poole) to be the production of William of Conches.

The most permanent contribution of Bede to scientific thought in this field was his revival of the view that the firmament is made of ice; and he supported this from the words in the twenty-sixth chapter of Job, "He bindeth up the waters in his thick cloud, and the cloud is not rent under them."

About the beginning of the ninth century appeared the third in that triumvirate of churchmen who were the oracles of sacred science throughout the early middle ages—Rabanus Maurus, Abbot of Fulda and Archbishop of Mayence. Starting, like all his predecessors, from the first chapter of Genesis, borrowing here and there from the ancient philosophers, and excluding everything that could conflict with the letter of Scripture, he follows, in his work upon the universe, his two predecessors, Isidore and Bede, developing especially Bede's theory that the firmament is strong enough to hold up the "waters above the heavens," because it was made of ice.*

For centuries the authority of these three great teachers was unquestioned, and in countless manuals and catechisms their doctrine was translated and diluted for the common mind.† But, about the second quarter of the twelfth century, a priest, Honorius of Autun, produced several treatises which show that thought on this subject had made some little progress. He explained the rain rationally, and mainly in the modern manner; with the thunder he is less successful, but insists that the thunderbolt "is not stone, as some assert." His thinking is vigorous and independent.‡ Had theorists such as he been many, a new science could have been rapidly evolved, but the theological current was too strong.

The strength of this current which overwhelmed the thought of Honorius is seen again in the work of the Dominican monk, John of San Geminiano, who in the thirteenth century gave forth his "Summa de Exemplis" for the use of preachers in his order. Of its thousand pages, over two hundred are devoted to illustrations drawn from the heavens and the elements. A characteristic specimen is his explanation of the Psalmist's phrase, "The arrows of the thunder." These, he tells us, are forged out of a dry vapor rising from the earth and kindled by the heat of the upper air, which then, coming into contact with a cloud just turning into rain, "is conglutinated like flour into dough," but, being too hot to be extinguished, its particles become

* See Rabanus Maurus, "Comment. in Genesim" and "De Universo" (Migne, "Patr. Lat.," cvii, cxi).

† For a charmingly *naïve* example of these primers, see the little Anglo-Saxon manual of astronomy, sometimes attributed to Ælfric. It is in the vernacular, but is translated in Wright's "Popular Treatises on Science during the Middle Ages." Bede is, of course, its chief source.

‡ See Honorius Augustodunensis, "De imagine mundi," and "Hexæmeron" (Migne, "Patr. Lat.," clxxii). The "De philosophia mundi," the most rational of all, is, however, believed by modern scholars to be unjustly ascribed to him. See note above.

merely sharpened at the lower end, and so blazing arrows, cleaving and burning everything they touch." *

But far more important in the thirteenth century was the fact that the most eminent scientific authority of that age, Albert the Great, Bishop of Ratisbon, attempted to reconcile the speculations of Aristotle with the theological views derived from the fathers. In one very important respect he improved upon the meteorological views of his great master. The thunderbolt, he says, is no mere fire, but the product of black clouds containing much mud, which, when it is baked by the intense heat, forms a fiery black or red stone that falls from the sky, tearing beams and crushing walls in its course: such he has seen with his own eyes.†

The monkish encyclopedists of the later middle ages added little to these theories. As we glance over the pages of Vincent of Beauvais, Bartholomew of Glanville, and William of Conches, we note only a growing deference to the authority of Aristotle as supplementing that of Isidore and Bede and explaining sacred Scripture. Aristotle is treated like a church Father, but extreme care is taken not to go beyond the great maxim of Saint Augustine; then, little by little, Bede and Isidore fall into the background, Aristotle fills the whole horizon, and his utterances are second in sacredness only to the text of Holy Writ.

A curious illustration of the difficulties these mediæval scholars had to meet in reconciling the scientific theories of Aristotle with the letter of the Bible is seen in the case of the rainbow. It is to the honor of Aristotle that his conclusions regarding the rainbow, though slightly erroneous, were based upon careful observation and evolved by reasoning alone; but his Christian commentators, while anxious to follow him, were brought up against the scriptural statement that God had created the rainbow as a sign to Noah that there should never again be a Flood on the earth. Even so bold a thinker as Cardinal Pierre d'Ailly, whose speculations as to the geography of the earth did so much afterward in stimulating Columbus, faltered before this statement, acknowledging that God alone could explain it; but suggested that possibly never before the deluge had a cloud been suffered to take such a position toward the sun as to cause a rainbow.‡

The learned cardinal was also constrained to believe that certain stars and constellations have something to do in causing the rain, since these would best explain Noah's foreknowledge of the Deluge. In connection with this scriptural doctrine of winds came a scriptural

* See Joannes à S. Geminiano, "Summa," c. 75.

† See Albertus Magnus, "II Sent.," Opp. xv, 137, a. (cited by Heller, "Gesch. d. Physik," i, 184) and his "Liber Methaurorum," III, iv, 18 (of which I have used the edition of Venice, 1488).

‡ See his "Concordia astronomicæ veritatis cum theologia" (Paris, 1483—in his "Imago mundi"—and Venice, 1490); also Eck's commentary on Aristotle's "Meteorologica" (Augsburg, 1519).

doctrine of earthquakes: they were believed to be caused by winds issuing from the earth, and this view was based upon the passage in the one hundred and thirty-fifth Psalm, "He bringeth the wind out of his treasuries."*

Such were the main typical attempts during nearly fourteen centuries to build up under theological guidance and within scriptural limitations a sacred science of meteorology. But these theories were mainly evolved in the effort to establish a basis and general theory of phenomena: it still remained to account for special manifestations, and here came a development of theological thought far more important.

This development was twofold: on the one hand, these phenomena were attributed to the Almighty; and, on the other, to Satan. As to the first of these theories, we constantly find the divine wrath mentioned by the earlier fathers as the cause of lightning, hail-storms, hurricanes, and the like.

At the very beginning of Christianity we see a curious struggle between pagan and Christian belief upon this point. Near the close of the second century the Emperor Marcus Aurelius, in his effort to save the empire, fought a hotly-contested battle with the Quadi, in what is now Hungary. While the issue of this great battle was yet doubtful, there came suddenly a blinding storm beating into the faces of the Quadi. This gave the Roman troops the advantage, and enabled Marcus Aurelius to win a decisive victory. Votaries of each of the great religions claimed that this storm was caused by the object of their own adoration. The pagans insisted that Jupiter had sent the storm in obedience to their prayers, and on the Antonine Column at Rome we may still see the figure of Olympian Jove casting his thunderbolts and pouring a storm of rain from the open heavens against the Quadi. On the other hand, the Christians insisted that the storm had been sent by Jehovah in obedience to *their* prayers; and Tertullian, Eusebius, Saint Gregory of Nyssa, and Saint Jerome were among those who insisted upon this meteorological miracle—the first two, indeed, in the fervor of their arguments for its reality, allowing themselves to be carried considerably beyond exact historical truth.†

As time went on, the Fathers developed this view more and more from various texts in the Jewish and Christian sacred books, substituting for Jupiter flinging his thunderbolts the Almighty wrapped in thunder and sending forth his lightnings. Through the middle ages this was fostered until it became a mere truism, entering into all me-

* See Reisch, "Margarita philosophica," ix, 18, and Eck, "Arist. Meteor." (as above), ii, nota 2.

† For the authorities, pagan and Christian, see the note of Merivale, in his "History of the Romans under the Empire," chap. lxviii. He refers, for still fuller citations, to Fynes Clinton's "Fast. Rom.," p. 24.

diæval thinking, and was still further developed by an attempt to specify the particular sins which were thus punished. In the twelfth century the Florentine historian, Villani, ascribed floods and fires to the "too great pride of the city of Florence and the ingratitude of the citizens toward God," which, "of course," says a recent historian, "meant their insufficient attention to the ceremonies of religion." *

In the thirteenth century the Cistercian monk, Cæsar of Heisterbach, popularized the doctrine in Central Europe. His rich collection of anecdotes for the illustration of religious truths was the favorite recreative reading in the convents for three centuries, and exercised great influence over the thought of the later middle ages; and in this work he relates several instances of the divine use of lightning, both for rescue and for punishment. Thus he tells us how the steward (*cellerarius*) of his own monastery was saved from the clutch of a robber by a clap of thunder which, in answer to his prayer, burst suddenly from the sky and frightened the bandit from his purpose; how, in a Saxon theatre, twenty men were struck down, while a priest escaped, not because he was not a greater sinner than the rest, but because the thunderbolt had respect for his profession! It is Cæsarius, too, who tells us the story of the priest of Treves, struck by lightning in his own church, whither he had gone to ring the bell against the storm, and whose sins were revealed by the course of the lightning; for it tore his clothes from him and consumed certain parts of his body, showing that the sins for which he was punished were vanity and unchastity.†

This mode of explaining the divine interference more minutely is developed century after century, and we find both Catholics and Protestants assigning as causes of unpleasant meteorological phenomena whatever appears to them wicked, or even unorthodox. Among the English reformers, Tyndale quotes in this kind of argument the thirteenth chapter of I. Samuel, showing that, when God gave Israel a king, it thundered and rained.‡ Archbishop Whitgift, Bishop Bale, and Bishop Pilkington insisted on the same view.# In Protestant Germany, about the same period, Plieninger took a dislike to the new Gregorian calendar, and published a volume of "Brief Reflections," in which he insisted that the elements had given utterance to God's anger against it, calling attention to the fact that violent storms raged over almost all Germany during the very ten days which the Pope had taken out for the correction of the year, and that great floods began with the first days of the corrected year.‖

* See Trollope, "History of Florence," i, 64.

† See Cæsarius Heisterbacensis, "Dialogus miraculorum," x, c. 28-30.

‡ See Tyndale, "Doctrinal Treatises," 194 (in Parker Society publications).

\# See Whitgift, "Works," 477-483; Bale, "Works," 244, 245; and Pilkington, "Works," 177, 536 (both in Parker Society publications). Bishop Bale cites especially Job xxxviii, Ecclesiasticus xiii, and Revelation viii, as supporting the theory.

‖ See Janssen, "Geschichte des deutschen Volkes," v, 350, for Plieninger's words.

Early in the seventeenth century, Majoli, Bishop of Voltoraria, in southern Italy, produced his huge work, "Dies Caniculari," or "Dog-Days," which remained a favorite encyclopædia in Catholic lands for over a hundred years. Treating of thunder and lightning, he compares them to bombs against the wicked, and says that the thunderbolt is "an exhalation condensed and cooked into stone," and that "it is not to be doubted that, of all instruments of God's vengeance, the thunderbolt is the chief"; that by means of it Sennacherib and his army were consumed; that Luther was struck by lightning in his youth as a caution against departing from the Catholic faith; that blasphemy and Sabbath-breaking are the sins to which this punishment is especially assigned, and he cites the case of Dathan and Abiram.* Fifty years later the Jesuit Stengel developed this line of thought still further in four thick quarto volumes on the judgments of God, adding an elaborate schedule for the use of preachers in the sermons of an entire year. Three chapters were devoted to thunder, lightning, and storms. That the author teaches the agency in these of diabolical powers goes without saying; but this can only act, he declares, by divine permission, and the thunderbolt is always the finger of God, which rarely strikes a man save for his sins, and the nature of the special sin thus punished may be inferred from the bodily organs smitten.† A few years later, in Protestant Swabia, Pastor George Nuber issued a whole volume of "weather-sermons," in which he discusses nearly every sort of elemental disturbances—storms, floods, droughts, lightning, and hail. These, he says, come direct from God for human sins, yet no doubt with discrimination, for there are five sins which God especially punishes with lightning and hail, namely, impenitence, incredulity, neglect of the repair of churches, fraudulence in the payment of tithes to the clergy, and oppression of subordinates, each of which points he supports with a mass of scriptural texts.‡

This doctrine having become especially precious both to Catholics and to Protestants, there were issued hand-books of prayers against bad weather: among these was the "Spiritual Thunder and Storm Booklet," produced in 1731 by a Protestant scholar, Stöltzlin, whose three or four hundred pages of prayer and song, "sighs for use when it lightens fearfully," and "cries of anguish when the hail-storm is drawing on," show a wonderful adaptability to all possible meteorological emergencies. The preface of this volume is contributed by Professor Dilherr, pastor of the great church of St. Sebald at Nuremberg, who, in discussing the divine purposes of storms, adds to the three usually assigned—namely, God's wish to manifest his power, to display his anger, and to drive sinners to repentance—a fourth, which, he says, is

* See Majoli, "Dies Can.," I, i.

† See Stengelius, "De judiciis divinis," ii, 15–61, and especially the example of the "*impurus et saltator sacerdos, fulmine castratus*" (pp. 26, 27).

‡ See Nuber, "Conciones meteoricæ" (Ulm, 1661).

that God may show us "with what sort of a storm-bell he will one day ring in the last judgment." *

About the end of the first quarter of the eighteenth century, we find, in Switzerland, even the eminent and rational Professor of Mathematics, Scheuchzer, publishing a "Physica Sacra," with the Bible as a basis, and forced to admit that the elements, in the most literal sense, utter the voice of God. The same pressure was felt in New England. Typical are the sermons of Increase Mather on "The Voice of God in Stormy Winds." He especially lays stress on the voice of God speaking to Job out of the whirlwind, and upon the text, "Wind and storm fulfilling his word." He declares, "When there are great tempests, the angels oftentimes have a hand therein, . . . yea, and sometimes evil angels." He gives several cases of blasphemers struck by lightning, and says, "Nothing can be more dangerous for mortals than to condemn dreadful providences, and, in particular, dreadful tempests." †

His distinguished son, Cotton Mather, disentangled himself somewhat from the old view, as he had done in the interpretation of comets.‡ In his "Christian Philosopher," his "Thoughts for the Day of Rain," and his "Sermon preached at the Time of the Late Storm" (in 1723), he is evidently tending toward the modern view. Yet, from time to time, the older view has reasserted itself; and in France, as recently as the year 1870, we find the Bishop of Verdun ascribing the drought afflicting his diocese to the sin of Sabbath-breaking.

This theory, which attributed injurious meteorological phenomena mainly to the purposes of God, was a natural development, and comparatively harmless; but at a very early period there was evolved another theory, which, having been ripened into a doctrine, cost the earth dear indeed. Never, perhaps, in the modern world has there been a dogma more prolific of physical, mental, and moral agony throughout whole nations and during whole centuries.# This theory, its development by theology, its fearful results to mankind, and its destruction by scientific observation and thought, will form the subject of my next chapter.

* See Stöltzlin, "Geistliches Donner- und Wetter-Büchlein" (Zürich, 1731).

† See Increase Mather, "The Voice of God," etc. (Boston, 1704). This rare volume is in the rich collection of the American Antiquarian Society at Worcester.

‡ See a chapter on this subject, by the present writer, in "The Popular Science Monthly" for October, 1885. A new edition, with large additions, has been recently published by the American Historical Association.

\# See the "Semaine relig. de Lorraine," 1870, p. 445 (cited by "Paul Parfait," in his "Dossier des Pèlerinages," 141–143).

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M. Wroblewski has made a successful application of the electric light to the magic-lantern projection of opaque objects. In the midst of darkness a strong light is concentrated on the object, which becomes intensely illuminated, and its picture may be thrown upon the canvas with the colors fully brought out and even made more brilliant.

# MENTAL DIFFERENCES OF MEN AND WOMEN.

By GEORGE J. ROMANES.

IN his "Descent of Man" Mr. Darwin has shown at length that what Hunter termed secondary sexual characters occur throughout the whole animal series, at least as far down in the zoölogical scale as the Articulata. The secondary sexual characters with which he is chiefly concerned are of a bodily kind, such as plumage of birds, horns of mammals, etc. But I think it is evident that secondary sexual characters of a mental kind are of no less general occurrence. Moreover, if we take a broad view of these psychological differences, it becomes instructively apparent that a general uniformity pervades them—that while within the limits of each species the male differs psychologically from the female, in the animal kingdom as a whole the males admit of being classified, as it were, in one psychological species and the females in another. By this, of course, I do not mean that there is usually a greater psychological difference between the two sexes of the same species than there is between the same sexes of different species: I mean only that the points wherein the two sexes differ psychologically are more or less similar wherever these differences occur.

It is probably due to a recognition of this fact that from the very earliest stages of culture mankind has been accustomed to read into all nature—inanimate as well as animate—differences of the same kind. Whether it be in the person of Maya, of the pagan goddesses, of the Virgin Mary, or in the personifications of sundry natural objects and processes, we uniformly encounter the conception of a feminine principle coexisting with a masculine in the general frame of the cosmos. And this fact, as I have said, is presumably due to a recognition by mankind of the uniformity as well as the generality of psychological distinction as determined by sex.

I will now briefly enumerate what appeared to me the leading features of this distinction in the case of mankind, adopting the ordinary classification of mental faculties as those of intellect, emotion, and will.

Seeing that the average brain-weight of women is about five ounces less than that of men, on merely anatomical grounds we should be prepared to expect a marked inferiority of intellectual power in the former.* Moreover, as the general physique of women is less robust

* This is proportionally a greater difference than that between the male and female organisms as a whole, and the amount of it is largely affected by grade of civilization—being least in savages and most in ourselves. Moreover, Sir J. Crichton Browne informs me, as a result of many observations which he is now making upon the subject, that not only is the gray matter, or cortex, of the female brain shallower than that of the male,

than that of men—and therefore less able to sustain the fatigue of serious or prolonged brain-action—we should also, on physiological grounds, be prepared to entertain a similar anticipation. In actual fact we find that the inferiority displays itself most conspicuously in a comparative absence of originality, and this more especially in the higher levels of intellectual work. In her powers of acquisition the woman certainly stands nearer to the man than she does in her powers of creative thought, although even as regards the former there is a marked difference. The difference, however, is one which does not assert itself till the period of adolescence—young girls being, indeed, usually more acquisitive than boys of the same age, as is proved by recent educational experiences both in this country and in America. But as soon as the brain, and with it the organism as a whole, reaches the stage of full development, it becames apparent that there is a greater power of amassing knowledge on the part of the male. Whether we look to the general average or to the intellectual giants of both sexes, we are similarly met with the general fact that a woman's information is less wide, and deep, and thorough, than that of a man. What we regard as a highly-cultured woman is usually one who has read largely but superficially; and even in the few instances that can be quoted of extraordinary female industry—which, on account of their rarity, stand out as exceptions to prove the rule—we find a long distance between them and the much more numerous instances of profound erudition among men. As musical executants, however, I think that equality may be fairly asserted.

But it is in original work, as already observed, that the disparity is most conspicuous. For it is a matter of ordinary comment that in no one department of creative thought can women be said to have at all appreached men, save in fiction. Yet in poetry, music, and painting, if not also in history, philosophy, and science, the field has always been open to both.* For, as I will presently show, the disabilities under which women have labored with regard to education, social opinion, and so forth, have certainly not been sufficient to explain this general dearth among them of the products of creative genius.

Lastly, with regard to judgment, I think there can be no real ques-

but also receives less than a proportional supply of blood. For these reasons, and also because the differences in question date from an embryonic period of life, he concludes that they constitute "a fundamental sexual distinction, and not one that can be explained on the hypothesis that the educational advantages enjoyed either by the individual man or by the male sex generally through a long series of generations have stimulated the growth of the brain in the one sex more than in the other."

* The disparity in question is especially suggestive in the case of poetry, seeing that this is the oldest of the fine arts which have come down to us in a high degree of development, that its exercise requires least special education or technical knowledge, that at no level of culture has such exercise been ostracized as unfeminine, that nearly all languages present several monuments of poetic genius of the first order, and yet that no one of these has been reared by a woman.

tion that the female mind stands considerably below the male. It is much more apt to take superficial views of circumstances calling for decision, and also to be guided by less impartiality. Undue influence is more frequently exercised from the side of the emotions; and, in general, all the elements which go to constitute what is understood by a characteristically judicial mind of comparatively feeble development. Of course, here, as elsewhere, I am speaking of average standards. It would be easy to find multitudes of instances where women display better judgment than men, just as in the analogous cases of learning and creative work. But that as a general rule the judgment of women is inferior to that of men has been a matter of universal recognition from the earliest times. The man has always been regarded as the rightful lord of the woman, to whom she is by nature subject, as both mentally and physically the weaker vessel; and when in individual cases these relations happen to be inverted, the accident becomes a favorite theme for humorists—thus showing that in the general estimation such a state of matters is regarded as incongruous.

But if woman has been a loser in the intellectual race as regards acquisition, origination, and judgment, she has gained, even on the intellectual side, certain very conspicuous advantages. First among these we must place refinement of the senses, or higher evolution of sense-organs. Next we must place rapidity of perception, which no doubt in part arises from this higher evolution of the sense-organs—or, rather, both arise from a greater refinement of nervous organization. Houdin, who paid special attention to the acquirement of rapidity in acts of complex perception, says he has known ladies who, while seeing another lady "pass at full-speed in a carriage, could analyze her toilet from her bonnet to her shoes, and be able to describe not only the fashion and quality of the stuffs, but also to say if the lace were real or only machine-made." Again, reading implies enormously intricate processes of perception, both of the sensuous and intellectual order; and I have tried a series of experiments, wherein reading was chosen as a test of the rapidity of perception in different persons. Having seated a number of well-educated individuals round a table, I presented to them successively the same paragraph of a book, which they were each to read as rapidily as they could, ten seconds being allowed for twenty lines. As soon as time was up I removed the paragraph, immediately after which the reader wrote down all that he or she could remember of it. Now, in these experiments, where every one read the same paragraph as rapidly as possible, I found that the palm was usually carried off by the ladies. Moreover, besides being able to read quicker, they were better able to remember what they had just read—that is, to give a better account of the paragraph as a whole. One lady, for example, could read exactly four times as fast as her husband, and could then give a better account even of that portion of the paragraph which alone he had had time to get through. For the consolation of such husbands, however, I may add that rapidity of perception as thus tested is no evidence of what may be termed the deeper qualities of mind—some of my slowest readers being highly distinguished men.

Lastly, rapidity of perception leads to rapidity of thought, and this finds expression on the one hand in what is apt to appear as almost intuitive insight, and on the other hand in that nimbleness of motherwit which is usually so noticeable and often so brilliant an endowment of the feminine intelligence, whether it displays itself in tact, in repartee, or in the general alacrity of a vivacious mind.

Turning now to the emotions, we find that in woman, as contrasted with man, these are almost always less under control of the will—more apt to break away, as it were, from the restraint of reason, and to overwhelm the mental chariot in disaster. Whether this tendency displays itself in the overmastering form of hysteria, or in the more ordinary form of comparative childishness, ready annoyance, and a generally unreasonable temper—in whatever form this supremacy of emotion displays itself, we recognize it as more of a feminine than a masculine characteristic. The crying of a woman is not held to betray the same depth of feeling as the sobs of a man; and the petty forms of resentment which belong to what is known as a "shrew," or a "scold," are only to be met with among those daughters of Eve who prove themselves least agreeable to the sons of Adam. Coyness and caprice are very general peculiarities, and we may add, as kindred traits, personal vanity, fondness of display, and delight in the sunshine of admiration. There is also, as compared with the masculine mind, a greater desire for emotional excitement of all kinds, and hence a greater liking for society, pageants, and even for what are called "scenes," provided these are not of a kind to alarm her no less characteristic timidity. Again, in the opinion of Mr. Lecky, with which I partly concur:

> In the courage of endurance they are commonly superior; but their passive courage is not so much fortitude which bears and defies, as resignation which bears and bends. In the ethics of intellect they are decidedly inferior. They very rarely love truth, though they love passionately what they call "the truth," or opinions which they have derived from others, and hate vehemently those who differ from them. They are little capable of impartiality or doubt; their thinking is chiefly a mode of feeling; though very generous in their acts, they are rarely generous in their opinions or in their judgments. They persuade rather than convince, and value belief as a source of consolation rather than as a faithful expression of the reality of things.

But, of course, as expressed in the well-known lines from "Marmion," there is another side to this picture, and, in now taking leave of all these elements of weakness, I must state my honest conviction that they are in chief part due to women as a class not having hitherto enjoyed the same educational advantages as men. Upon this great question of female education, however, I shall have more to say at the close of this paper, and only allude to the matter at the present stage in order to temper what I feel to be the almost brutal frankness of my remarks.

But now, the meritorious qualities wherein the female mind stands pre-eminent are, affection, sympathy, devotion, self-denial, modesty; long-suffering, or patience under pain, disappointment, and adversity; reverence, veneration, religious feeling, and general morality. In these virtues—which agree pretty closely with those against which the apostle says there is no law—it will be noticed that the gentler predominate over the heroic; and it is observable in this connection that when heroism of any kind is displayed by a woman, the prompting emotions are almost certain to be of an unselfish kind.

All the æsthetic emotions are, as a rule, more strongly marked in women than in men—or, perhaps, I should rather say, they are much more generally present in women. This remark applies especially to the æsthetic emotions which depend upon refinement of perception. Hence feminine "taste" is proverbially good in regard to the smaller matters of every-day life, although it becomes, as a rule, untrustworthy in proportion to the necessity for intellectual judgment. In the arrangement of flowers, the furnishing of rooms, the choice of combinations in apparel, and so forth, we generally find that we may be most safely guided by the taste of women; while in matters of artistic or literary criticism we turn instinctively to the judgment of men.

If we now look in somewhat more detail at the habitual display of these various feelings and virtues on the part of women, we may notice, with regard to affection, that, in a much larger measure than men, they derive pleasure from receiving as well as from bestowing: in both cases affection is felt by them to be, as it were, of more emotional value. The same remark applies to sympathy. It is very rare to find a woman who does not derive consolation from a display of sympathy, whether her sorrow be great or small; while it is by no means an unusual thing to find a man who rejects all offers of the kind with a feeling of active aversion.

Touching devotion, we may note that it is directed by women pretty equally toward inferiors and superiors—spending and being spent in the tending of children; ministering to the poor, the afflicted, and the weak; clinging to husbands, parents, brothers, often without and even against reason.

Again, purity and religion are, as it were, the natural heritage of women in all but the lowest grades of culture. But it is within the limit of Christendom that both these characters are most strongly pronounced; as, indeed, may equally well be said of nearly all the other virtues which we have just been considering. And the reason is that Christianity, while crowning the virtue of chastity with an aureole of mysticism more awful than was ever conceived even by pagan Rome, likewise threw the vesture of sanctity over all the other virtues which belong by nature to the female mind. Until the rise of Christianity the gentler and domestic virtues were nowhere recognized as at all comparable, in point of ethical merit, with the heroic and the civic. But when the ideal was changed by Christ—when the highest place in the hierarchy of the virtues was assigned to faith, hope, and charity; to piety, patience, and long-suffering; to forgiveness, self-denial, and even self-abasement—we can not wonder that, in so extraordinary a collision between the ideals of virtue, it should have been the women who first flocked in numbers around the standard of the Cross.

So much, then, for the intellect and emotions. Coming lastly to the will, I have already observed that this exercises less control over the emotions in women than in men. We rarely find in women that firm tenacity of purpose and determination to overcome obstacles which is characteristic of what we call a manly mind. When a woman is urged to any prolonged or powerful exercise of volition, the prompting cause is usually to be found in the emotional side of her nature, whereas, in man, we may generally observe that the intellectual is alone sufficient to supply the needed motive. Moreover, even in those lesser displays of volitional activity, which are required in close reading or in studious thought, we may note a similar deficiency. In other words, women are usually less able to concentrate their attention; their minds are more prone to what is called "wandering," and we seldom find that they have specialized their studies or pursuits to the same extent as is usual among men. This comparative weakness of will is further manifested by the frequency among women of what is popularly termed indecision of character. The proverbial fickleness of *la donna mobile* is due quite as much to vacillation of will as to other unstable qualities of mental constitution. The ready firmness of decision which belongs by nature to the truly masculine mind is very rarely to be met with in the feminine; while it is not an unusual thing to find among women indecision of character so habitual and pronounced as to become highly painful to themselves—leading to timidity and diffidence in adopting almost any line of conduct where issues of importance are concerned, and therefore leaving them in the condition, as they graphically express it, of not knowing their own minds.

If, now, we take a general survey of all these mental differences, it becomes apparent that in the feminine type the characteristic virtues, like the characteristic failings, are those which are born of weakness; while in the masculine type the characteristic failings, like the characteristic virtues, are those which are born of strength. Which we are to consider the higher type will therefore depend on the value which we assign to mere force. Under one point of view, the magnificent spider of South America, which is large enough and strong enough to devour a humming-bird, deserves to be regarded as the superior creature. But, under another point of view, there is no spectacle in nature more shockingly repulsive than the slow agonies of the most beautiful of created beings in the hairy limbs of a monster so far beneath it in the sentient as in the zoölogical scale. And although the contrast between man and woman is happily not so pronounced in degree, it is nevertheless a contrast the same in kind. The whole organization of woman is formed on a plan of greater delicacy, and her mental structure is correspondingly more refined : it is further removed from the struggling instincts of the lower animals, and thus more nearly approaches our conception of the spiritual. For even the failings of weakness are less obnoxious than the vices of strength, and I think it is unquestionable that these vices are of quite as frequent occurrence on the part of men as are those failings on the part of women. The hobnailed boots may have given place to patent pumps, and yet but small improvement may have been made upon the overbearing temper of a navvy; the beer-shop may have been superseded by the whist-club, and yet the selfishness of pleasure-seeking may still habitually leave the solitary wife to brood over her lot through the small hours of the morning. Moreover, even when the mental hobnails have been removed, we generally find that there still remains what a member of the fairer sex has recently and aptly designated mental heavy-handedness. By this I understand the clumsy inability of a coarser nature to appreciate the feelings of a finer ; and how often such is the case we must leave the sufferers to testify. In short, the vices of strength to which I allude are those which have been born of rivalry : the mental hide has been hardened, and the man carries into his home those qualities of insensibility, self-assertion, and self-seeking which have elsewhere led to success in his struggle for supremacy. Or, as Mr. Darwin says: "Man is the rival of other men ; he delights in competition, and this leads to ambition which passes too readily into selfishness. These latter qualities seem to be his natural and unfortunate birthright."

Of course, the greatest type of manhood, or the type wherein our ideal of manliness reaches its highest expression, is where the virtues of strength are purged from its vices. To be strong and yet tender, brave and yet kind, to combine in the same breast the temper of a hero with the sympathy of a maiden—this is to transform the ape and the tiger into what we know ought to constitute the man. And if in actual life we find that such an ideal is but seldom realized, this should make us more lenient in judging the frailties of the opposite sex. These frailties are, for the most part, the natural consequences of our own, and even where such is not the case, we do well to remember, as already observed, that they are less obnoxious than our own, and also that it is the privilege of strength to be tolerant. Now, it is a practical recognition of these things that leads to chivalry; and even those artificial courtesies which wear the mark of chivalry are of value, as showing what may be termed a conventional acquiescence in the truth that underlies them. This truth is, that the highest type of manhood can only then be reached when the heart and mind have been so far purified from the dross of a brutal ancestry as genuinely to appreciate, to admire, and to reverence the greatness, the beauty, and the strength which have been made perfect in the weakness of womanhood.

I will now pass on to consider the causes which have probably operated in producing all these mental differences between men and women. We have already seen that differences of the same kind occur throughout the whole mammalian series, and therefore we must begin by looking below the conditions of merely human life for the original causes of these differences in their most general form. Nor have we far to seek. The Darwinian principles of selection—both natural and sexual—if ever they have operated in any department of organic nature, must certainly have operated here. Thus, to quote Darwin himself:

> Among the half-human progenitors of man, and among savages, there have been struggles between the males during many generations for the possession of the females. But mere bodily strength and size would do little for victory, unless associated with courage, perseverance, and determined energy. . . . To avoid enemies or to attack them with success, to capture wild animals, and to fashion weapons, requires reason, invention, or imagination. . . . These latter faculties, as well as the former, will have been developed in man partly through sexual selection—that is, through the contest of rival males—and partly through natural selection—that is, from success in the general struggle for life; and as in both cases the struggle will have been during maturity, the characters gained will have been transmitted more fully to the male than to the female offspring. . . . Thus man has ultimately become superior to woman. It is, indeed, fortunate that the law of the equal transmission of characters to both sexes prevails with mammals; otherwise it is probable that man would have become as superior in mental endowment to woman as the peacock is in ornamental plumage to the peahen.

Similarly, Mr. Francis Galton writes:

> The fundamental and intrinsic differences of character that exist in individuals are well illustrated by those that distinguish the two sexes, and which begin to assert themselves even in the nursery, where all children are treated alike. One notable peculiarity in the woman is that she is capricious and coy, and has less straightforwardness than the man. It is the same with the female of every species. . . . [Were it not so], the drama of courtship, with its prolonged strivings and doubtful success, would be cut quite short, and the race would degenerate through the absence of that sexual selection for which the protracted preliminaries of love-making give opportunity. The willy-nilly disposition of the female is as apparent in the butterfly as in the man, and must have been continually favored from the earliest stages of animal evolution down to the

present time. Coyness and caprice have in consequence become a heritage of the sex, together with a cohort of allied weaknesses and petty deceits, that men have come to think venial, and even amiable, in women, but which they would not tolerate among themselves.

We see, then, that the principles of selection have thus determined greater strength, both of body and mind, on the part of male animals throughout the whole mammalian series; and it would certainly have been a most unaccountable fact if any exception to this rule had occurred in the case of mankind. For, as regards natural selection, it is in the case of mankind that the highest premium has been placed upon the mental faculties—or, in other words, it is here that natural selection has been most busy in the evolution of intelligence—and therefore, as Mr. Darwin remarks, we can only regard it as a fortunate accident of inheritance that there is not now a greater difference between the intelligence of men and of women than we actually find. Again, as regards sexual selection, it is evident that here also the psychologically segregating influences must have been exceptionally strong in the case of our own species, seeing that in all the more advanced stages of civilization—or in the stages where mental evolution is highest, and, therefore, mental differences most pronounced—marriages are determined quite as much with reference to psychical as to physical endowments; and as men always admire in women what they regard as distinctively feminine qualities of mind, while women admire in men the distinctively masculine, sexual selection, by thus acting directly as well as indirectly on the mental qualities of both, is constantly engaged in molding the minds of each upon a different pattern.

Such, then, I take to be the chief, or at least the original, causes of the mental differences in question. But besides these there are sundry other causes all working in the same direction. For example, as the principles of selection have everywhere operated in the direction of endowing the weaker partner with that kind of physical beauty which comes from slenderness and grace, it follows that there has been everywhere a general tendency to impart to her a comparative refinement of organization; and in no species has this been the case in so high a degree as in man. Now, it is evident from what has been said in an earlier part of this paper, that general refinement of this kind indirectly affects the mind in many ways. Again, as regards the analogous, though coarser, distinction of bodily strength, it is equally evident that their comparative inferiority in this respect, while itself one of the results of selection, becomes in turn the cause of their comparative timidity, sense of dependence, and distrust of their own powers on the part of women, considered as a class. Hence, also, their comparative feebleness of will and vacillation of purpose: they are always dimly conscious of lacking the muscular strength which, in the last resort, and especially in primitive stages of culture, is the measure of executive capacity. Hence, also, their resort to petty arts and pretty ways for the securing of their aims; and hence, in large measure, their strongly religious bias. The masculine character, being accustomed to rely upon its own strength, is self-central and self-contained: to it the need of external aid, even of a supernatural kind, is not felt to be so urgent as it is to the feminine character, whose only hope is in the stronger arm of another. "The position of man is to stand, of woman to lean"; and although it may be hard for even a manly nature to contemplate the mystery of life and the approach of death with a really Stoic calm, at least this is not so impossible as it is for the more shrinking and emotional nature of a woman. Lastly, from her abiding sense of weakness and consequent dependence, there also arises in woman that deeply-rooted desire to please the opposite sex which, beginning in the terror of a slave, has ended in the devotion of a wife.

We must next observe another psychological lever of enormous power in severing the mental structures of men and women. Alike in expanding all the tender emotions, in calling up from the deepest fountains of feeling the flow of purest affection, in imposing the duties of rigid self-denial, in arousing under its strongest form the consciousness of protecting the utterly weak and helpless consigned by Nature to her charge, the maternal instincts are to woman perhaps the strongest of all influences in the determination of character. And their influence in this respect continues to operate long after the child has ceased to be an infant. Constant association with her growing children—round all of whom her affections are closely twined, and in all of whom the purest emotions of humanity are as yet untouched by intellect—imparts to the mother a fullness of emotional life, the whole quality of which is distinctively feminine. It has been well remarked by Mr. Fiske that the prolonged period of infancy and childhood in the human species must from the first "have gradually tended to strengthen the relations of the children to the mother," and, we may add, also to strengthen the relations of the mother to the children—which implies an immense impetus to the growth in her of all the altruistic feelings most distinctive of woman. Thus, in accordance with the general law of inheritance as limited by sex, we can understand how these influences became, in successive generations, cumulative; while in the fondness of little girls for dolls we may note a somewhat interesting example in psychology of the law of inheritance at earlier periods of life, which Mr. Darwin has shown to be so prevalent in the case of bodily structures throughout the animal kingdom.

There remains, so far as I can see, but one other cause which can be assigned of the mental differences between men and women. This cause is education. Using the term in its largest sense, we may say that in all stages of culture the education of women has differed widely from that of men. The state of abject slavery to which woman is consigned in the lower levels of human evolution clearly tends to dwarf her mind *ab initio*. And as woman gradually emerges from this her primitive and long-protracted condition of slavery, she still continues to be dominated by the man in numberless ways, which, although of a less brutal kind, are scarcely less effectual as mentally dwarfing influences. The stunting tendency upon the female mind of all polygamous institutions is notorious, and even in monogamous or *quasi*-monogamous communities so highly civilized as ancient Greece and pagan Rome, woman was still, as it were, an intellectual cipher—and this at a time when the intellect of man had attained an eminence which has never been equaled. Again, for a period of about two thousand years after that time civilized woman was the victim of what I may term the ideal of domestic utility—a state of matters which still continues in some of the Continental nations of Europe. Lastly, even when woman began to escape from this ideal of domestic utility, it was only to fall a victim to the scarcely less deleterious ideal of ornamentalism. Thus Sydney Smith, writing in 1810, remarks: "A century ago the prevailing taste in female education was for housewifery; now it is for accomplishments. The object now is to make women artists—to give them an excellence in drawing, music, and dancing." It is almost needless to remark that this is still the prevailing taste; the ideal of female education still largely prevalent in the upper classes is not that of mental furnishing, but rather of mental decoration. For it was not until the middle of the present century that the first attempt was made to provide for the higher education of women, by the establishment of Queen's College and Bedford College in London. Twenty years later there followed Girton and Newnham at Cambridge; later still Lady Margaret and Somerville at Oxford, the foundation of the Girls' Public Day-Schools Company, the opening of degrees to women at the University of London, and of the honor examinations at Cambridge and Oxford.

We see, then, that with advancing civilization the theoretical equality of the sexes becomes more and more a matter of general recognition, but that the natural inequality continues to be forced upon the observation of the public mind; and chiefly on this account—although doubtless also on account of traditional usage—the education of women continues to be, as a general rule, widely different from that of men. And this difference is not merely in the positive direction of laying greater stress on psychological embellishment: it extends also in the negative direction of sheltering the female mind from all those influences of a striving and struggling kind, which constitute the practical schooling of the male intellect. Woman is still regarded by public opinion all the world over as a psychological plant of tender growth, which needs to be protected from the ruder blasts of social life in the conservatories of civilization. And, from what has been said in the earlier part of this paper, it will be apparent that in this practical judgment I believe public opinion to be right. I am, of course, aware that there is a small section of the public—composed for the most part of persons who are not accustomed to the philosophical analysis of facts—which argues that the conspicuous absence of women in the field of intellectual work is due to the artificial restraints imposed upon them by all the traditional forms of education; that if we could suddenly make a leap of progress in this respect, and allow women everywhere to compete on fair and equal terms with men, then, under these altered circumstances of social life, women would prove themselves the intellectual compeers of man.

But the answer to this argument is almost painfully obvious. Although it is usually a matter of much difficulty to distinguish between nature and nurture, or between the results of inborn faculty and those of acquired knowledge, in the present instance no such difficulty obtains. Without again recurring to the anatomical and physiological considerations which bar *a priori* any argument for the natural equality of the sexes, and without remarking that the human female would but illustrate her own deficiency of rational development by supposing that any exception to the general laws of evolution can have been made in her favor—without dwelling on any such antecedent considerations, it is enough to repeat that in many departments of intellectual work the field *has* been open, and equally open, to both sexes. If to this it is answered that the traditional usages of education lead to a higher average of culture among men, thus furnishing them with a better vantage-ground for the origin of individual genius, we have only to add that the strong passion of genius is not to be restrained, by any such minor accidents of environment. Women by tens of thousands have enjoyed better educational as well as better social advantages than a Burns, a Keats, or a Faraday; and yet we have neither heard their voices nor seen their work.

If, again, to this it be rejoined that the female mind has been unjustly dealt with in the past, and can not now be expected all at once to throw off the accumulated disabilities of ages—that the long course of shameful neglect to which the selfishness of man has subjected the culture of woman, has necessarily left its mark upon the hereditary constitution of her mind—if this consideration be adduced, it obviously does not tend to prove the equality of the sexes; it merely accentuates the fact of inequality by indicating one of its causes. The treatment of women in the past may have been very wrong, very shameful, and very much to be regretted by the present advocates of women's rights; but proof of the ethical quality of this fact does not get rid of the fact itself, any more than a proof of the criminal nature of assassination can avail to restore to life a murdered man. We must look the facts in the face. How long it may take the woman of the future to recover the ground which has been lost in the psychological race by the woman of the past, it is impossible to say; but we may predict with confidence that, even under the most favorable conditions as to culture, and even supposing the mind of man to remain stationary (and not, as is probable, to advance with a speed relatively accelerated by the momentum of its already acquired velocity), it must take many centuries for heredity to produce the missing five ounces of the female brain.

In conclusion, a few words may be added on the question of female education as this actually stands at the present time. Among all the features of progress which will cause the present century to be regarded by posterity as beyond comparison the most remarkable epoch in the history of our race, I believe that inauguration of the so-called woman's movement in our own generation, will be considered one of the most important. For I am persuaded that this movement is destined to grow ; that with its growth the highest attributes of one half of the human race are destined to be widely influenced ; that this influence will profoundly react upon the other half, not alone in the nursery and the drawing-room, but also in the study, the academy, the forum, and the senate ; that this latest yet inevitable wave of mental evolution can not be stayed until it has changed the whole aspect of civilization. In an essay already alluded to, Sydney Smith has remarked, though not quite correctly, that up to his time there had been no woman who had produced a single notable work, either of reason or imagination, whether in English, French, German, or Italian literature. A few weeks ago Mrs. Fawcett was able to show us that since then there have been at least forty women who have left a permanent mark in English literature alone. Now this fact becomes one of great significance when we remember that it is the result of but the earliest phase of the woman's movement. For, as already indicated, this movement is now plainly of the nature of a ferment. When I was at Cambridge, the then newly-established foundations of Girton and Newnham were to nearly all of us matters of amusement. But we have lived to alter our views ; for we have lived to see that that was but the beginning of a great social change, which has since spread, and is still spreading, at so extraordinary a rate that we are now within measurable distance of the time when no English lady will be found to have escaped its influence. It is not merely that women's colleges are springing up like mushrooms in all quarters of the kingdom, or that the old type of young ladies' governess is being rapidly starved out of existence. It is of much more importance even than this that the immense reform in girls' education, which has been so recently introduced by the Day-Schools Company working in conjunction with the University Board and local examinations, has already shaken to its base the whole system, and even the whole ideal, of female education, so that there is scarcely a private school in the country which has not been more or less affected by the change. In a word, whether we like it or not, the woman's movement is upon us ; and what we have now to do is to guide the flood into what seem likely to prove the most beneficial channels. What are these channels?

Of all the pricks against which it is hard to kick, the hardest are those which are presented by Nature in the form of facts. Therefore we may begin by wholly disregarding those short-sighted enthusiasts who seek to overcome the natural and fundamental distinction of sex. No amount of female education can ever do this, nor is it desirable that it should. On this point I need not repeat what is now so often and so truly said, as to woman being the complement, not the rival, of man. But I should like to make one remark of another kind. The idea underlying the utterances of all these enthusiasts seems to be that the qualities wherein the male mind excels that of the female are, *sui generis*, the most exalted of human faculties: these good ladies fret and fume in a kind of jealousy that the minds, like the bodies, of men are stronger than those of women. Now, is not this a radically mistaken view? Mere strength, as I have already endeavored to insinuate, is not the highest criterion of nobility. Human nature is a very complex thing, and among the many ingredients which go to make the greatness of it even intellectual power is but one, and not by any means the chief. The truest grandeur of that nature is revealed by that nature as a whole, and here I think there can be no doubt that the feminine type is fully equal to the masculine, if indeed it be not superior. For I believe that if we all go back in our memories to seek for the highest experience we have severally had in this respect, the character which will stand out as all in all the greatest we have ever known, will be the character of a woman. Or, if any of us have not been fortunate in this matter, where in fiction or in real life can we find a more glorious exhibition of all that is best—the mingled strength and beauty, tact, gayety, devotion, wit, and consummate ability—where but in a woman can we find anything at once so tender, so noble, so lovable, and so altogether splendid as in the completely natural character of a Portia? A mere blue-stocking, who looks with envy on the intellectual gifts of a Voltaire, while shutting her eyes to the gifts of a sister such as this, is simply unworthy of having such a sister: she is incapable of distinguishing the pearl of great price among the sundry other jewels of our common humanity.

Now, the suspicion, not to say the active hostility, with which the so-called woman's movement has been met in many quarters, springs from a not unhealthy ground of public opinion. For there can be no real doubt that these things are but an expression of the value which that feeling attaches to all which is held distinctive of feminine character as it stands. Woman, as she has been bequeathed to us by the many and complex influences of the past, is recognized as too precious an inheritance lightly to be tampered with; and the dread lest any change in the conditions which have given us this inheritance should lead, as it were, to desecration, is in itself both wise and worthy. In this feeling we have the true safeguard of womanhood ; and we can hope for nothing better than that the deep, strong voice of social opinion will always be raised against any innovations of culture which may tend to spoil the sweetest efflorescence of evolution.

But, while we may hope that social opinion may ever continue opposed to the woman's movement in its most extravagant forms—or to those forms which endeavor to set up an unnatural, and therefore an impossible, rivalry with men in the struggles of practical life—we may also hope that social opinion will soon become unanimous in its encouragement of the higher education of women. Of the distinctively feminine qualities of mind which are admired as such by all, ignorance is certainly not one. Therefore learning, as learning, can never tend to deteriorate those qualities. On the contrary, it can only tend to refine the already refined, to beautify the already beautiful—"when our daughters shall be as corner-stones, polished after the similitude of a palace." It can only tend the better to equip a wife as the helpmeet of her husband, and by furthering a community of tastes, to weave another bond in the companionship of life. It can only tend the better to prepare a mother for the greatest of her duties—forming the tastes and guiding the minds of her children at a time when these are most pliable, and under circumstances of influence such as can never again be reproduced.

It is nearly eighty years ago since this view of the matter was thus presented to Sydney Smith :

> If you educate women to attend to dignified and important subjects, you are multiplying beyond measure the chances of human improvement by preparing and medicating those early impressions which always come from the mother, and which, in the majority of instances, are quite decisive of genius. The instruction of women improves the stock of national talents, and employs more minds for the instruction and improvement of the world: it increases the pleasures of society by multiplying the topics upon which the two sexes take a common interest, and makes marriage an intercourse of understanding as well as of affection. The education of women favors public morals; it provides for every season of life, and leaves a woman when she is stricken by the hand of Time, not as she now is, destitute of everything and neglected by all, but with the full power and the splendid attractions of knowledge—diffusing the elegance of polite literature, and receiving the homage of learned and accomplished men.

Since the days when this was written, the experiment of thus educating women to attend to dignified and important subjects has been tried on a scale of rapidly-increasing magnitude, and the result has been to show that those apprehensions of public opinion were groundless which supposed that the effect of higher education upon women would be to deteriorate the highest qualities of womanhood. On this point I think it is sufficient to quote the opinion of a lady who has watched the whole course of this experiment, and who is so well qualified to give an opinion that it would be foolish presumption in any one else to dispute what she has to say. The lady to whom I refer is Mrs. Sidgwick, and this is what she says:

> The students that I have known have shown no inclination to adopt masculine sentiments or habits in any unnecessary or unseemly degree; they are disposed to imitate the methods of life and work of industrious undergraduates just as far as these appear to be means approved by experience to the end which both sets of students have in common, and nothing that I have seen of them, either at the university or afterward, has tended in the smallest degree to support the view that the adaptation of women to domestic life is so artificial and conventional a thing that a few years of free, unhampered study and varied companionship at the university has a tendency to impair it.

So far as I am aware, only one other argument has been, or can be, adduced on the opposite side. This argument is that the physique of young women as a class is not sufficiently robust to stand the strain of severe study, and therefore that many are likely to impair their health more or less seriously under the protracted effort and acute excitement which are necessarily incidental to our system of school and university examinations. Now, I may begin by remarking that with this argument I am in the fullest possible sympathy. Indeed, so much is this the case that I have taken the trouble to collect evidence from young girls of my own acquaintance who are now studying at various high-schools with a view to subsequently competing for first classes in the Cambridge triposes. What I have found is that in some of these high-schools—carefully observe, only in *some*—absolutely no check is put upon the ambition of young girls to distinguish themselves and to bring credit upon their establishments. The consequence is that in these schools the more promising pupils habitually undertake an amount of intellectual work which it is sheer madness to attempt. A single quotation from one of my correspondents—whom I have known from a child—will be enough to prove this statement:

> I never begin work later than six o'clock, and never work less than ten or eleven hours a day. But within a fortnight or so of my examinations I work fifteen or sixteen hours. Most girls, however, stop at fourteen or fifteen hours, but some of them go on to eighteen hours. Of course, according to the school time-tables, none of us should work more than eight hours; but it is quite impossible for any one to get through the work in that time. For instance, in the time-tables ten minutes is put down for botany, whereas it takes the quickest girl an hour and a half to answer the questions set by the school lecturer.

These facts speak for themselves, and therefore I will only add that in many of those high-schools for girls which are situated in large towns no adequate provision is made for bodily exercise, and this, of course, greatly aggravates the danger of overwork. In such a school there is probably no play-ground; the gymnasium, if there is one, is not attended by any of the harder students; drill is never thought of; and the only walking exercise is to and from the school. Let it not be supposed that I am attacking the high-school system.

On the contrary, I believe that this system represents the greatest single reform that has ever been made in the way of education. I am only pointing out certain grave abuses of the system which are to be met with in some of these schools, and against which I should like to see the full force of public opinion directed. There is no public school in the kingdom where a boy of sixteen would be permitted to work from eleven to eighteen hours a day, with no other exercise than a few minutes' walk. Is it not, then, simply monstrous that a girl should be allowed to do so? I must confess that I have met with wonderfully few cases of serious breakdown. All my informants tell me that, even under the operation of so insane an abuse as I have quoted, grave impairment of health but rarely occurs. This, however, only goes to show of what good stuff our English girls are made; and therefore may be taken to furnish about the strongest answer I can give to the argument which I am considering—viz., that the strength of an average English girl is not to be trusted for sustaining any reasonable amount of intellectual work. Upon this point, however, there is at the present time a conflict of medical authority, and, as I have no space to give a number of quotations, it must suffice to make a few general remarks.

In the first place, the question is one of fact, and must therefore be answered by the results of the large and numerous experiments which are now in progress; not by any *a priori* reasoning of a physiological kind. In the next place, even as thus limited, the inquiry must take account of the wisdom or unwisdom with which female education is pursued in the particular cases investigated. As already remarked, I have been myself astonished to find so great an amount of prolonged endurance exhibited by young girls who are allowed to work at unreasonable pressure; but, all the same, I should of course regard statistics drawn from such cases as manifestly unfair. And seeing that every case of health impaired is another occasion given to the enemies of female education, those who have the interests of such education at heart should before all things see to it that the teaching of girls be conducted with the most scrupulous precautions against over-pressure. Regarded merely as a matter of policy, it is at the present moment of far more importance that girls should not be overstrained than that they should prove themselves equal to young men in the class lists. For my own part, I believe that, with reasonable precautions against over-pressure, and with due provision for bodily exercise, the higher education of women would *ipso facto* silence the voice of medical opposition. But I am equally persuaded that this can never be the case until it becomes a matter of general recognition among those to whom such education is intrusted, that no girl should ever be allowed to work more than eight hours a day as a *maximum;* that even this will in a large proportional number of cases be found to prove excessive; that without abundant exercise higher education should never be attempted; and that, as a girl is more liable than a boy to insidiously undermine her constitution, every girl who aspires to any distinction in the way of learning should be warned to be constantly on the watch for the earliest symptoms of impairment. If these reasonable precautions were to become as universal in the observance as they now are in the breach, I believe it would soon stand upon the unquestionable evidence of experimental proof, that there is no reason in the nature of things why women should not admit of culture as wide and deep and thorough as our schools and universities are able to provide.

The channels, therefore, into which I should like to see the higher education of women directed are not those which run straight athwart the mental differences between men and women which we have been considering. These differences are all complementary to one another, fitly and beautifully joined together in the social organism. If we attempt to disregard them, or try artifically to make of woman an unnatural copy of man, we are certain to fail, and to turn out as our result a sorry and disappointed creature who is neither the one thing nor the other. But if, without expecting women as a class to enter into any professional or otherwise foolish rivalry with men, for which as a class they are neither physically nor mentally fitted, and if, as Mrs. Lynn Linton remarks, we do not make the mistake of confusing mental development with intellectual specialization—if, without doing either of these things, we encourage women in every way to obtain for themselves the intrinsic advantages of learning, it is as certain as anything can well be that posterity will bless us for our pains. For then all may equally enjoy the privilege of a real acquaintance with letters; ladies need no longer be shut out from a solid understanding of music or painting; lecturers on science will no longer be asked at the close of their lectures whether the cerebellum is inside or outside of the skull, how is it that astronomers have been able to find out the names of the stars, or whether one does not think that his diagram of a jelly-fish serves with admirable fidelity to illustrate the movements of the solar system. These, of course, I quote as extreme cases, and even as displaying the prettiness which belongs to a child-like simplicity. But simplicity of this kind ought to be put away with other childish things; and in whatever measure it is allowed to continue after childhood is over, the human being has failed to grasp the full privileges of human life. Therefore, in my opinion, the days are past when any enlightened man ought seriously to suppose that in now again reaching forth her hand to eat of the tree of knowledge, woman is preparing for the human race a second fall. In the person of her admirable representative, Mrs. Fawcett, she thus pleads: "No one of those who care most for the woman's movement cares one jot to prove or to maintain that men's brains and women's brains are exactly alike or exactly equal. All we ask is that the social and legal status of women should be such as to foster, not to suppress, any gift for art, literature, learning, or goodness with which woman may be endowed." Then, I say, give her the apple, and see what comes of it. Unless I am greatly mistaken, the result will be that which is so philosophically as well as so poetically portrayed by the Laureate:

> "The woman's cause is man's: they rise or sink
> Together, dwarfed or godlike, bond or free.
>
> . . . . . .
>
> "Then let her make herself her own
> To give or keep, to live and learn to be
> All that not harms distinctive womanhood.
> For woman is not undeveloped man,
> But diverse: could we make her as the man,
> Sweet Love were slain: his dearest bond is this,
> Not like to like, but like in difference.
>
> "Yet in the long years liker must they grow;
> The man be more of woman, she of man;
> He gain in sweetness and in moral height,
> Nor lose the wrestling thews that throw the world;
> She mental breadth, nor fail in childward care.
> Nor lose the child-like in the larger mind;
> Till at the last she set herself to man,
> Like perfect music unto noble words.
>
> . . . . . .
>
> "Then comes the statelier Eden back to men:
> Then reign the world's great bridals, chaste and calm:
> Then springs the crowning race of human kind.
> May these things be!"

—*Nineteenth Century.*

## MODERN OVER-EDUCATION.

THE appeal made by Professor Jowett, in the columns of the "Times," for state aid to provincial colleges established to promote "higher education," naturally raises the question how high education for the bulk of mankind ought to go. The world has heard something too much of the subject of late years, and the theme has been worn rather threadbare. Every lecturer in want of a topic, every Radical member of Parliament, bound to deliver an address to his constituents, and having exhausted his wrath against the House of Lords and the landed interest and his ideas on the Irish question, finds an unfailing resource in discoursing on education, in which he may deliver himself of platitudes *ad libitum*, and raise an approving cheer by informing his audience for the fiftieth time that "knowledge is power." It has ever been a boon to the Socialists and other democrats, who have discovered in their scheme of free education a convenient means of drawing upon the income of one class for the benefit of another. School boards make continually increasing demands upon the property of the rich, and, in the true spirit of all Liberal legislation, tyrannically encroach upon the liberties of the poor. Cramming and competition, standards and examinations, are being multiplied to such an extent that they occupy a large portion of human life, which is becoming a scene of probation indeed, in a sense in which the phrase was never before used. At this rate of progress we seem likely soon to arrive at the educational absurdity which prevails in the Chinese Empire, where an official in his ninetieth year has recently passed his "final examination," which places him on the pinnacle of Chinese wisdom and enrolls him in the most exalted rank of mandarins, a sublime elevation which the lengthened period of study it has taken to acquire it has left him little time to enjoy.

But, in spite of all this clamor, it is open to question whether the present rising generation are well educated, or even educated, in the original and natural sense of the word, at all. The Latin word *educo*, from which our English word is derived, means simply to draw out or train. To strengthen the faculties, to sharpen the intelligence, and to form the character—are any of these objects attained, or even aimed at, in modern education? Practically only one faculty—memory—is cultivated at the expense of all the rest, and that is overburdened. The impossible is attempted, and the young mind strained and exhausted, rather than strengthened, in the desperate effort to acquire a superficial acquaintance with almost every form of human knowledge, in order to answer the catch-questions of an examiner, who would be baffled by his own wisdom if he had not the resource of referring, when his memory fails him, to his notes or his books. A boy has now no time to digest and assimilate what he acquires, nor has he any encouragement to do so. He must "think nothing gained while aught remains," and push on to new conquests until either the dreaded day of examination arrives, or his health breaks down, and renders him unfit to be examined, or perhaps unequal to any occupation at all. The simple course of education of the ancient Persians, to ride, to draw the bow, and to speak the truth, had its advantages as compared with the modern system. Of course, in these days it is not possible to be satisfied with so limited a curriculum, though the native virtue of speaking the truth might with advantage be cultivated much more diligently than it is, more especially by some of our public men, who, by-the-way, are the real teachers, for they it is who complete the education of men who in their turn teach the youth. But some approach might be made to the simplicity of the Greek system, which, based upon the truism that it is impossible to overstrain the mind in a healthy body, in full exercise, seems to have been directed chiefly to strengthening the frame and the mental powers without exhausting either, cultivating a taste for study, and to acquiring the arts of rhetoric and elocution. For most men at the present day this is enough ; an exception, of course, must be made of those who are intended for a learned profession, and especially of those whose life is to be spent in instructing others. Clergymen and schoolmasters must be well instructed, or they can not teach. A certain number of scholars and men of science are necessary, but it is not necessary that any of us should attempt the acquisition of universal knowledge. It is not possible, nor desirable, if it were possible, that all should become Bentleys or Porsons. Education does enough if it puts into the hands of youth the key of knowledge, and teaches how to use it. It does too much if it exhausts the brain, and burdens the memory with an immense number of facts which can not be permanently retained with sufficient accuracy to be useful, and which as frequently dwarf as enlarge the intellect by checking its tendency to originate. The creative faculties of the mind are its noblest part, and what encouragement to them is given by the system of modern education? An original opinion expressed in an essay may run counter to the prejudices and hurt the feelings of the examiner, who promptly revenges himself by depriving the examinee of the marks to which he is fairly entitled. This is no imaginary case, but it can be corroborated by many an unlucky victim of this Chinese system, who has not comprehended that we have imported with it the Celestial habit of close imitation, and that we must now not only read but think in a groove, and follow, as closely as we are able to discover them, the peculiarities of the examiner's mind, after the manner of the Chinese tailor who, being directed to make a European coat on the model of an old one supplied to him, reproduced it in *fac-simile*, patches and all. Fortunately, most of these professors have written books ; it is, therefore, in most cases easy enough to win their good graces by a slavish imitation, which is said to be the most delicate and seductive kind of flattery. Thus both are ingeniously demoralized, and learning certainly is not advanced. But are not the advantages of education, even of the best, greatly overrated? One spark of genius is worth all that was ever taught in schools. Who are the men who have enlightened and transformed the world? Certainly not the most highly educated. It might almost be maintained that those who have done most have learned least from others. Alexander the Great, indeed, was highly educated for his time, but, as he began active life at sixteen, when he commanded a wing of his father's army at the battle of Chæronea, he had not leisure to acquire much ; and it may safely be affirmed that it was not the precepts of Aristotle which showed him how to overthrow the Persian Empire, and leave a name which will be remembered as long as the world shall last. His acute intellect, his daring spirit, his boundless ambition, resistless and untiring energy, and his iron will were his instructors, and made him the master of the world. "Sweetest Shakespeare, Fancy's child," did not acquire the power to warble "his native wood-notes wild" at the village school, which yet prepared him sufficiently to enable him to display his genius. Newton as a boy was averse to study, and though he took a degree at Cambridge, it was not that of senior wrangler, yet what mathematician has equaled him in reputation, or in the importance of his discoveries? Watt, the inventor of the steam-engine, and Whitworth, who made the tools by the use of which it has been brought to its present perfection, were both self-taught. The same may be said of Arkwright, and almost every discoverer who has been a real public benefactor. In the loftier ranks of the leaders of mankind education has never played an important part. Cromwell's youth was passed in idleness and obscurity; he had no instruction even in the military art, in which he had no rival in his day.

Lord Beaconsfield was never at a public school, nor passed through a university, and all the education he ever received appears to have been what would now be thought merely rudimentary, but it was enough for him. His stores of knowledge must have been acquired only by reading; but this armory, in his skillful hands, provided him with weapons quite adequate to an encounter with even his most formidable adversaries. The world is not governed, or even perceptibly influenced, by professors or Admirable Crichtons. It is ruled by men of action. The daring genius of Clive did more for England, and even for the advancement of the human race, by establishing that Pax-Britannica, under which 140,000,000 human beings now enjoy protection and prosperity, than all the learning of the schools. . . . The only education worthy of the name is that which, by hardening and invigorating the frame, lays the foundation of health of body and mind, which forms the character, imparts sufficient knowledge to enable each individual to cultivate the special taste which Nature has given him, and, instead of teaching only the art of passing examinations, endeavors to inspire all with the solid virtues of courage, self-reliance, honor, and religion, and makes a living, thinking, acting being, full of resource, spirit, and energy, not a walking encyclopædia—in one word, a man, and not a "professor."—*Land and Water.*

## SKETCH OF ISAAC LEA.

FEW naturalists have enjoyed a longer working-life, or been able to make it more fruitful in finished achievement, than Isaac Lea. His first paper, being a simple account of the minerals then known to exist in the vicinity of Philadelphia, was published in 1818. Additions to this contribution were made but slowly for a few years, but as the list swelled they become frequent, giving evidence of indefatigable industry in research; and the last paper, standing as No. 279 on the catalogue, is dated 1876, closing a record of fifty-eight years of productive activity. During most of this time Dr. Lea was associated in the conduct of a large publishing-house, and was only able to give his hours of leisure to science.

Isaac Lea was born in Wilmington, Delaware, March 4, 1792. He was descended from ancestors who came over from Gloucestershire, England, with William Penn, and were described as "a couple of noted and valued preachers." He was the fifth son of James Lea, a wholesale merchant, and was at first put in a course of classical instruction at the academy in Wilmington, in preparation for the medical profession. This purpose was afterward given up, and, when he was fifteen years old, Isaac was sent to Philadelphia to engage in mercantile business in association with his brother. He had inherited a strong taste for Nature from his mother, and found a congenial spirit in Professor Vanuxem, then also a youth, with whom he formed the habit of making collecting excursions around the city. The two companions were soon led, by what they found and observed, to inquiry into the composition and structure of the rocks; they had to pursue it at first without any guidance, but in a short time became acquainted with the mineralogical collection of Dr. Adam Seybert. A diversion to their pursuits was given by the occurrence of the war with Great Britain in 1812. They joined a volunteer rifle company, which offered its services to the Governor. Although the company was disbanded without being called into service, young Lea had, by joining it, engaged enough in war to violate the principles of the Society of Friends, and he lost his birthright in it. Among the excursions which the two youths made was one to the coal-mines near Wilkesbarre, where they found slates containing mollusca, which Lea described forty years afterward in the "Journal of the Academy of Natural Sciences." They walked back, over the Pocono Mountain through the Wind-Gap, where Lea found the first trilobite they had ever seen, and down the Delaware River. In 1815 they were both elected members of the Philadelphia Academy of Natural Sciences, and began to take active parts in its proceedings; and in this society Mr. Lea read his first paper, already referred to, embodying the results of many years of close observation which the friends had made upon the rocks during their excursions.

On the publication, in 1818, of Professor Silliman's prospectus of the "American Journal of Science," Mr. Lea procured the names of fourteen subscribers to the journal—an act which Professor Silliman afterward declared "was the turning-point of the scheme"; for, receiving such encouragement from a person with whom he had no personal acquaintance, he was sure the journal would be successful. Mr. Lea contributed several papers to the early numbers of this journal, at the editor's request; but the article of this period which is perhaps most worthy of special mention, is one that he published in 1828 in the "American Quarterly Review," on the Northwest Passage, in which he expressed the opinion that, if the passage were ever made, it must be, as was indicated by the direction of the currents, from west to east. This hypothesis was verified in 1852 by Captain McClure's making the passage in the direction described.

As Mr. Lea advanced in his geological studies, he found that it was necessary to know something of shells. In order to study their genera as described by Lamarck, he imported a large collection of shells from China. He soon became interested in this branch of the science, and ultimately made it the leading object of his researches. A collection of several species of *Unio*, including some beautiful and rare specimens, was sent to the Academy of Natural Sciences, in 1825, by Major Long, of the Engineer Corps, who had obtained them in dredging the channel of the Ohio River below Louisville. At about the same time, Mr. Lea's brother Thomas, having engaged to look after the shells in the vicinity of Cincinnati, where he was living, shipped a barrel of shells of rare beauty, including six new species. The description of these specimens—"Description of Six New Specimens of the Genus Unio"—presented to the American Philosphical Society in 1827, formed the first of that long series of papers on the *Unio* and allied shells which constitute the chief of Mr. Lea's works. Yet, at the time he presented it, he had no thought that he should ever have another word to say on the subject, for at that time no one conceived the infinite variety of species of the family which American waters are now known to contain. As a side-result of Mr. Lea's interest in the *Unios* may be mentioned the conversion of his brother from an indifferent barreler of shells for another to an enthusiastic student of land-shells and botany, and to be the author of a monograph on "The Plants of Cincinnati."

Dr. Lea spent the traveling season of 1832 in Europe, where the journal of his excursions is a record of successive introductions to famous scientific men, and interesting conversations with them, in which he was never the only one who received information. In London he attended a meeting of the Geological Society, and met most of the leading geologists of Great Britain. At Oxford, he attended the second meeting of the British Association, over which Dr. Buckland presided. Meeting Dr. Buckland afterward in London, the conversation turned upon the quantity of coal in the United States. Dr. Buckland thought we had very little coal. Dr. Lea pointed out on a map the coal-fields of the United States as they were then known. After several hours spent in the examination of the matter, Dr. Buckland taking notes all the time, the distinguished geologist remarked, as he took his leave to meet an engagement, that England had enough coal to supply the United States when its supply should fail. Dr. Lea replied that the quantity of anthracite and bituminous coal was almost unlimited in North America, and promised to send him maps and sections that would satisfy him upon the subject. He fulfilled his promise after he returned home, and, upon the evidence thus afforded, Dr. Buckland presented a paper to the next meeting of the British Association on the extent of our coal-supply. At the British Museum, by the request of Dr. Gray, Dr. Lea went over the collection of the *Unionidæ*, arranged and named them correctly, and added some new species from the United States. He called, in Paris, on Baron Ferussac, the eminent student of terrestrial and fluviatile mollusca, who was then engaged in preparing his great work on the *Unionidæ.* During the conversation the baron "complimented Dr. Lea by saying that he could not go on with his work until he (Dr. Lea) had finished his memoirs." Dr. Lea afterward spent several hours in going over the baron's collections, which contained *Unionidæ* from Brazil, Syria, Turkey, and Egypt, and rearranging it, cutting down the species and forming numerous synonyms. Afterward, he met Blainville, Ferussac, and others at the Jardin des Plantes, to arrange and name all the *Unionidæ* of the collection there, to which he added fourteen species. From Studer, the elder, in Berne, he received the last copy in the author's possession of his work on the land and fresh-water shells of Switzerland, and compliments on the papers he had himself written. At Paris, again, he examined the *Unionidæ* in the Duc de Rivoli's collection, which contained all those of Lamarck, and was thereby able to identify all of Lamarck's species in his subsequent memoir. Calling on M. Gay by invitation, he was shown all the mollusca which that naturalist had collected in his travels, and was invited to select a specimen of each. Thus he found the most eminent naturalists everywhere, on the strength of the few papers he had published on American mollusca, ready to welcome him as one of themselves, and to receive instruction from him. Their general message to him was to go on with the investigations he had begun, with the assurance that no naturalist in America or Europe had the advantages that he possessed.

On returning home in November, 1832, he found that he had been anticipated in a work he should have done on the Tertiary shells of Alabama, but, having specimens of the species in his cabinet, he prepared a paper, "Contributions to Geology," which he presented to the Academy of Natural Sciences in August, 1833. It contained two hundred and twenty-one species. His "Synopsis of the Family Naïades," published in 1836, and afterward supplemented and expanded, is said to have settled satisfactorily to most conchologists the synonymy of the species. On receiving it, Prince Charles Bonaparte expressed a desire to see all parts of zoölogy treated in the same manner. In 1849 Dr. Lea presented a paper on the foot-marks of the reptile *Sauropus primævus*, found by him in the red shales at Pottsville, Pennsylvania, seventeen hundred feet below the conglomerate, which was of interest on account of the discussion it excited as to the age of the fossil. The foot-prints were assigned to the old red sandstone, while Professor Agassiz had declared that he did not believe that any air-breathing animals had existed before the new red sandstone. The discussion was kept up for several years, in the course of which Dr. Lea reiterated and maintained his position that the fossil was what he represented it, and that the formation in which it was found was the one indicated by Rogers as No. XI. Its interest has since been diminished by the discovery and authentication of fossils of air-breathers in still older formations. Another series of papers of peculiar interest was that concerning the fossil saurian of the new red sandstone (*Clepsysaurus Pennsylvanicus*).

Having retired from business in 1851, Dr. Lea made another visit to Europe in 1852. Many of the incidents of his previous visit were substantially repeated, but in large part with naturalists of another generation than those whom he had met before. At Paris he arranged and named the *Unionidæ* in the cabinets of the eminent conchologists Boivin and Petit. He called upon Dr. Chenu to look for the original specimen of *Mulleria* of Ferussac, which had never been figured, but simply described as being in Lamarck's collection. "He told Dr. Chenu that he thought it must have been mixed with the *Etheria*, of which the collection had many specimens. Dr. Chenu declared this could not be so, or he would have seen it. As soon as he pulled out the drawer, Dr. Lea saw at a glance the identical specimen which Ferussac had described. He took it up and declared this to be it. Both the naturalists were surprised and delighted. . . . Thus Dr. Lea's theory of the genus *Acostea*, of D'Orbigny, was complete—it was a *Mulleria*." At Vienna he showed the Austrian naturalists some features in their species and specimens which had escaped their eyes. At Berlin he found Humboldt and other distinguished men of science much interested in what was going on in geology in the United States. At a dinner with the Philosophical Club in London, Sir Charles Lyell gave him credit for being the first and only one who had yet observed an air-breathing animal in so ancient a rock as that in which the *Sauropus primævus* occurred, and added that the *Clepsysaurus Pennsylvanicus* was the first discovery of bones in the new red sandstone, although a jaw of a similar animal had since been found. Colonel Sabine exhibited a bottle which he supposed had come through Behring Strait from Japan, which Dr. Lea was able to claim as a verification of his theory of a west-to-east Arctic current.

On his return home in November, 1853, Dr. Lea found an accumulation of correspondence and specimens awaiting his attention that hardly diminished, so incessant were the fresh arrivals, during the remainder of his active life, or for twenty-five years. Among his new Southern and Southwestern correspondents was Bishop Elliott, of Georgia, who became greatly interested in the mollusca of that State, and engaged others in interest in the subject and in collecting shells. The scientific researches of Dr. Lea were continued, with constant publications, until 1877, when a sudden illness which came upon him in Southern California disabled him from further vigorous work. He still, however, continued to add to his collections and perform such work upon them as his strength would allow. He gave much attention to the microscopic examination of quartz-crystals, with drawings and descriptions of the inclusions and markings of each, so that Professor H. Rosenbusch, in his work on the subject, mentioned him as having been the first in America to enter into microscopic mineralogy. He had engaged, since his return from Europe, in other branches of natural history than conchology. The elephant folio edition of the account of the fossil foot-marks near Pottsville elicited warm commendation for the beauty of its execution and illustration. In 1858 appeared a memoir on the embryology of the *Unionidæ*, giving descriptions and figures of thirty-eight species. In all of his papers he described eighteen hundred and seventy-two species of mollusks of various kinds, most of which were from the United States. The series was embodied in a private edition of thirteen volumes, with three indexes, which the author distributed among men of science and learned societies. Richard Owen, acknowledging the receipt of one of the volumes, said, "They represent a kind or class of labors the most genuine and important and lasting, in the hard endeavor to gain a knowledge of Nature." Professor Haidinger, of Vienna, said, on a similar occasion, that his work would "last as long as natural science shall be cultivated by mankind. The more it is compared and studied, the more appears your power of observation, your efforts in pursuing your object, your steadiness and perseverance." M. A. Boivin wrote, "You render a great service to science in devoting your time to the classification and description of the *Unio*." About ten thousand individuals were displayed in Dr. Lea's cabinet of *Unionidæ*, so arranged that each could be separately examined, and, in many instances, with a sequence from the youngest to the oldest, so as to exhibit the aspects of growth. His other cabinets contained nearly a thousand specimens of quartz-crystals, nearly five hundred of corundum, thirty-five drawers of the mica group, and several hundred sections of lamina prepared for the microscope.

In his ninety-fourth year Dr. Lea continued in good health, with his mental and physical faculties unimpaired; and in 1884 he was able to receive and entertain about two hundred members of the British Association at his cottage at Long Branch. He was President of the Academy of Natural Sciences in Philadelphia from 1853 to 1858, and was President of the American Association in 1860. The list given in his "Bibliography" of the society honors conferred upon him numbers twenty-eight titles, and concludes with an etc. A correspondent who maintained most intimate and confidential relations with Dr. Lea for more than twenty years, furnishes a sketch of his personal character and social life, from which we quote the following words:

"Possessing a mind of great vigor and culture, he was a most genial companion to those whose tastes and sympathies accorded with his own. He was an ardent admirer of the works of Nature; and his cultivated mind enabled him to perceive many qualities and properties in them, the beauties of which are not comprehended by a less gifted observer. Few objects escaped his notice. He possessed, in an eminent degree, a prompt and keen appreciation of the sublime and of the grotesque; and a speedy judgment in detecting merit or fraud, affectation or sincerity.

"Dr. Lea habitually, during a period of nearly half a century, spent many hours of the night in his studies and his writings, seldom relinquishing them before midnight. These night studies were continued, with little intermission, until he was nearly eighty years old; and they were gradually and finally abandoned only in compliance with the warnings of his medical adviser. Until Dr. Lea became enfeebled with age, at a late period in his life, it was a source of great delight to him to collect mineral specimens in Chester and Delaware Counties in Pennsylvania. His most frequent companions, on such occasions, were Mr. William W. Jefferis, formerly of West Chester, and the writer. No ardent school-boy manifested more enthusiasm in digging than he, when a fair prospect was afforded for obtaining specimens; and his well-trained eye quickly recognized a specimen, though covered with soil. He never permitted any person to clean his specimens excepting himself; and that operation he performed with great patience, in the most complete manner, in order to display all the beauties which the minerals possessed. He was familiar with nearly all the mineral localities in Eastern Pennsylvania. Many years ago the writer described a locality for minerals in Delaware County, which he supposed would be new to Dr. Lea, and received the following reply from him: 'I have crawled all over that locality, on my hands and knees, a half-dozen times, with good results every time.'

"Dr. Lea was a strong admirer of gems, and his familiarity with precious stones was so great that he was considered to be one of the best judges of them in this country. He devoted more time than any other mineralogist to the microscopic examination of the precious stones; the results from which were published, at various times, in the proceedings of the Academy of Natural Sciences. He possessed a large collection of precious stones from all the important localities in the world; and copious notes, in his own writing, are still attached to all the specimens.

"During the last few years of Dr. Lea's life, after he relinquished much of the active work in his mineral cabinet, his time was usually spent in his library, in the happy enjoyment of life, surrounded by his books referring to his favorite studies, mineralogy, geology, and conchology. He enjoyed especially the company of his scientific friends, and his interest in discussing scientific subjects was maintained until his final illness."

Another friend of Dr. Lea's expresses surprise that, in all the published notices of him, "no one has spoken of his wonderful powers of observation of Nature even in her minutest forms. You will pardon me if I say that I consider it one of his highest qualifications as a man of science. Nothing ever escaped his quick eye in the field or by the road-side when driving. Every tree, shrub, and flower, was full of interest to him, from which he ever imparted knowledge to his friends. In observing crystalline forms I believe he excelled others."

Another friend regards him from a different point of view, and says: "Something of his great-heartedness was revealed to even the casual observer. It found expression in form, and feature, and voice. Yet it was by those who knew him intimately that the social, affectional qualities of his nature were best perceived and most admired. Inheriting a loving spirit, and receiving the gentle impressions of a Christian home, he never lost his priceless dower. The demands of successful, enlarging business, the fondness for scientific study, the passion for scientific discovery, the allurements of fame, were wholly insufficient to make him other than amiable and self-forgetful. His home was the source and center of his delight. He gratefully acknowledged his indebtedness to those on whom he lavished his regard. During all the years in which he used even the night-watches for his investigations, the early hours of evening were spent, with free and joyous mind, in the midst of his family. He ever took more from himself than from others. Hospitality was the very genius of his house. With gentlest, heartiest courtesy his friends were welcomed to his fireside and his board. To those of scientific turn his rare and extensive scientific collections were opened with genuine delight. For those whose choice was in other directions, provision was made with equal care and gladness. Toward little children, and the young in general, his sympathies went forth with spontaneous freedom. He delighted to show to childish eyes, and to explain to childish comprehension, the beauties and marvels of Nature. Especially did he rejoice in giving encouragement to those who were struggling upward against great odds. The sight of such aspiration always awakened his enthusiastic interest. Not a few who to-day occupy positions of honor and usefulness owe their success to his appreciative, generous help. To envy his heart was wholly a stranger, and thus his friendships with men of science, both young and old, and with men great in other walks, were peculiarly tender and strong.

"In truth, his kindly interest included whatever affected the welfare of the race. He took pleasure in all honest effort. He exulted in all honorable achievement. He felt that he was personally indebted to whosoever made man better or more wise. In all social problems he took profound, unflagging interest. He sought to hold in view the progress of humanity in every land. In the alliance between religion and philanthropy and science he was a firm believer. He was confident that truth and right would triumph at last. To his perception the laws of Nature were the constancy of God's action, and Nature itself a transcript of the Eternal Mind."

# EDITOR'S TABLE.

## *A GREAT SCHOLAR ON EVOLUTION.*

As many of our readers are doubtless aware, the "Fortnightly Review" has lately opened its pages to a discussion of the present relations between theology and the general thought of the age. The subject has been approached by several writers from different points of view; and we can not but believe that the conflict of opinions will result in some solid gain to the cause of truth. Meantime we are interested in the criticism which the Rev. Dr. Burgon, Dean of Chichester, one of the disputants, in replying to Canon Fremantle, whose article was reproduced in our last number, has bestowed on the doctrine of evolution. Dr. Burgon is, we believe, one of the highest authorities on the textual criticism of the Scriptures now to be found in the Church of England. He has devoted a long life, he himself tells us, *exclusively* to that study. One would suppose that a man conscious of having given *all* his attention to one line of thought and research would be diffident about his competency in another and widely different one. Not so with Dr. Burgon, however; he is quite satisfied that he is as well able to deal with the doctrine of evolution as with the age of a Greek manuscript; and in the April "Fortnightly" he tells us just what he thinks on that subject in very emphatic and unmistakable terms. It is, he affirms, "utterly unscientific," a "wild hypothesis," "the merest impertinence," "the veriest foolishness." Does the reverend gentleman advance any arguments in support of these powerfully expressed opinions? Yes; and one of them is, that "man is *never found at all in a fossil state*." So convinced is the reverend doctor that this is a great truth, that he himself calls in the aid of italics to give it emphasis. Yet, had he opened the most elementary contemporary treatise on geology, he would have found that abundant fossil remains of man, and abundant traces also of his works, have been found in association with the bones of now extinct animals. The other arguments used by the doctor against the theory of evolution are drawn principally from the book of Genesis. He insists that man has not yet been quite six thousand years upon the earth, and quotes as an authority on that question Clinton, the author of "Fasti Hellenici." On the subject of miracles he has nothing better to tell us than that they are strictly analogous to human action in the realm of Nature: *ergo*, because man finds that he can do certain things by availing himself of natural laws, he must be ready to believe whatever may be told him of things done in apparent independence of all laws.

Dr. Burgon's article will do good. The extreme ignorance he manifests on scientific questions, and the unbounded confidence with which he nevertheless undertakes to discuss them, will open the eyes of many as to the pressing need for the scientific education of the clergy. A knowledge of manuscripts is all very well in its way; but a man who has to deal with the minds and hearts of other men, needs more than that. He needs to know the times he lives in, and the influences that are molding contemporary thought. Imagine, for a moment, a clergyman approaching an intelligent parishioner who is studying carefully the geological elements of the question as to the antiquity of man, and imagine that clergyman advising the parishioner to put aside his Lyell or his Geikie, and study Clinton's "Fasti" instead! Could a more absolutely absurd situation be conceived? Yet this is precisely what the learned Dean Burgon (who does not even know that fossil remains of man were ever found) does with all of us—tells us, if we want to be satisfied as to the age of the human species, to dismiss geology altogether, and betake ourselves to the guidance of a long-deceased chronologist! Probably the dean will never know what a lamentable exhibition he has made of himself—never know that, while denying the existence of fossil man, he gave in his own person an unequaled specimen of a fossilized human intellect. It seems to us not unlikely that, years hence, the dean's "Fortnightly" article will be quoted as one of the latest examples of an extreme type of clerical ignorance on scientific subjects; just as we now indicate the period when the cave-bear and mammoth bade adieu to this terrestrial scene. It will be a happy thing, indeed, to have such ignorance safely packed away among the treasures of the past.

But now appears another phase in the controversy referred to. The Rev. W. Benham, who describes himself as a conservative, both in theology and in politics, undertakes to answer both Canon Fremantle, the Broadchurchman, and his assailant Dean Burgon. Naturally, Mr. Benham does not go as far as Canon Fremantle; but he makes one very important statement, and that is, that the majority of the clergy, so far as his acquaintance extends, seem to assume the truth of the doctrine of evolution. If a man of conservative tendencies is able to say as much as this of the clerical brethren with whom he most consorts, and who, we may presume, are in the main conservatives also, it is evident that thought is moving fast in the Church of England.

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*THE FIGHT AGAINST POVERTY.*

As most of our readers are aware, an association has lately been formed in this city under the title of the "Anti-Poverty Society." It proposes to extirpate poverty by throwing the whole burden of taxation upon land. One may be allowed to doubt how far the proposed remedy, if found to be applicable, would go toward accomplishing the result desired; but, that poverty is an evil, and that the best efforts of modern society should be devoted to removing it, admits of no doubt. If the Anti-Poverty Society accomplishes no other good object, we trust it will at least, during the term of its existence, help to render the community more deeply sensible of its duty in this matter. When we speak of the community, however, we mean its individual members in their several private capacities, rather than the community as a politically organized body. We are not of those who hold that in legislation is to be found the cure for all social ills. On the contrary, we should be disposed to class what we may call the "legislation-habit" with what has been called the "alcohol-habit" in this important respect, that each implies resort to an artificial stimulus as a remedy for constitutional weaknesses—in one case in the social organism, in the other in the individual human body. Both involve distrust of, or disregard for, hygienic measures and the discipline of Nature; and both stand in the way of Nature's restorative action. If poverty is to be cured, we believe it can only be through the more general application of those principles and methods by which it is already warded off from the larger portion of society. The problem that has to be faced is the serious one of rendering every individual in the community fit to earn a maintenance for himself. Such fitness implies freedom from habits that are a burden upon life, from a physical or from any other point of view. Let the advocates of drastic measures of legislative reform say what they will, the fact remains that, given a certain measure of well-directed faculty, and success in the struggle of life becomes a sure thing. Instances abound in every country, but nowhere so much as in our own, in which men have risen, not only from the humblest but from the most disadvantageous beginnings to positions of wealth and influence. It is all a question of fitness. In the social sphere, as elsewhere, the fit will survive and flourish; the pre-eminently fit will flourish pre-eminently. It may be that pre-eminent fitness for present social conditions may not imply ideal excellence of character; no doubt it does not; still the fact remains that success is a question of adaptation, and that want of success or poverty means non-adaptation.

All this may seem very trite, but it would not be safe to argue that because a thing is trite all the good it is capable of yielding has been extracted from it. In the general craze for novelty, old truths are abandoned before they have been half worked out. The theories of the Anti-Poverty Society are very taking with the multitude; but we venture to predict that, after they have had their day, men will find that there is still much to do on the old lines to which we are now calling attention. The way to kill poverty, we hold, is to kill it individually—that is to say, to bring such influences to bear on the unfit as shall render them fit; to make war against idleness, inefficiency, stupidity, extravagance, weak self-indulgence, and all else that makes for poverty either by diminishing the productiveness of labor or by promoting undue consumption. It is sometimes held that the laboring classes do not get their fair share of the proceeds of their industry; but the fact is not insisted on as it might be that the share they get will at any given time be directly proportional to their own inherent merits as workers and as men. The question is how near can they come to negotiating on a footing of perfect equality with the employers of labor, and that depends upon the bearing and attitude which they are enabled to assume. A body of thoroughly intelligent and self-respecting men, with established habits of self-control and general capacity for self-guidance, would enter upon the negotiation with far better chances of concluding it to their satisfaction than would a body of men less intelligent and less under moral control, even allowing the latter the benefit of all the most improved appliances for industrial war, including street-rioting and the persecution of "scabs." It is mainly a moral and intellectual reform that is wanted; and we are far from saying that it is wanted only in the ranks of those who earn their bread by the labor of their hands. No serious person can consider the extravagance which now marks the expenditure of the middle and upper classes (if we may without offense use such terms as these to indicate comparative degrees of wealth), without feeling that a bad example of profusion and ostentation is shown to the wage-earners—that a wrong ideal of life is set before them. It is true now, as ever, that a man's life "consisteth not in the abundance of the things that he possesseth"; but it hardly seems as if any one to-day believed it. The majority at least only seem to live in proportion as they surround themselves with visible and tangible evidences of their material prosperity. One consequence—very important in relation to our present subject—is that a standard of living is set up which not all who become accustomed to it can permanently maintain; and thus extravagance leads to poverty. How many are miserably poor to-day whose parents brought them up in comfort, if not in affluence! We say "miserably poor," because poverty is never so miserable as when complicated with vain regrets and a general sense of disinheritance and decay. If we would fight against poverty, therefore, we must fight against it everywhere, and try to make all classes of society understand that life is a struggle for which a definite equipment is required, and that no part of that equipment is more essential than moderation of desire. Much, also, as the Malthusian doctrine is flouted in some quarters, and particularly in the region of the Anti-Poverty Society, the sober thought of the more instructed portion of mankind will incline them to believe that there is something to be said on behalf of prudence in incurring what is simply the most solemn and important responsibility than can be assumed by any human being. That poverty has been greatly promoted by carelessness and indifference in this regard—a blind trusting to chance or Providence—few, we think, would deny.

But perhaps the most important single aspect of the whole question is the sanitary or hygienic. As long as there are debilitated frames, enfeebled wills, and morbidly developed passions, there will be poverty. On the other hand, of course, poverty tends to increase and perpetuate these evils. This aspect of the subject has lately been treated with much force in the body of the "Monthly," and we shall not dwell upon it today. The main truth we wish to emphasize is that poverty results from unfitness for social conditions, and that the true mode of conducting an anti-poverty campaign would be to attack at every point those errors and vices that tend to depress human beings below the level at which they can fulfill the conditions needful for their maintenance in health and well-being.

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## LITERARY NOTICES.

Public Debts: An Essay in the Science of Finance. By Henry C. Adams, Ph. D. New York: D. Appleton & Co. Pp. 407. Price, $2.50.

The purpose of this treatise is to portray the principles which underlie the use of public credit. While it is neither primarily statistical nor historical, it relies upon statistics, and makes frequent appeals to history; and in these points, the experiences of our national Government, so comprehensive and recent, and of our State and local governments, so various and often so impressive, afford a rich fund whence illustration and the "clinchers" of argument are drawn. The peculiarity of our Federal Constitution necessitates a distinction in the treatment of the subject as between national deficit financiering and local deficit financiering (State and municipal) which is not recognized by European writers. Of the three parts into which the treatise is divided, the first is devoted to the general subject of "Public Borrowing as a Financial Policy." The immense development of public indebtedness which the world is now witnessing, which has reached an aggregate for the civilized states of $27,000,000,000, has taken place since 1848, when the total stood at $8,650,000,000. Searching for the causes of this accumulation, they are found to lie mainly in the greater strength and effectiveness of the feeling of nationality, for the maintenance of which large expenditures are necessary, and in the spirit of socialism, or the disposition of states to legislate and undertake in the interest of the social well-being of their peoples. Concerning the political and social tendencies and industrial effects of public borrowing, it is held that it tends to obviate the free workings of constitutional governments, to endanger the autonomy of inferior states, and to introduce complications between the larger powers. Socially, public debts render permanent such class relations as spring from disparity of possessions, and introduce conflicting interests between citizens. The industrial effects are complex, and depend upon the nature of the loan, the conditions under which it is contracted, and upon the fund of capital from which it is filled. They are harmful in proportion as the placement of the loan disturbs the market value of commodities. Public credit may be advantageously employed—as opposed to material increase of taxes—to cover running deficits, to assist in meeting unforeseen emergencies, and to provide revenue for carrying on public improvements. In the second part—"National Deficit Financiering"—the first topic is the "financial management of a war," the principle of which, as summarized, is "that reliance can not be placed wholly upon loans nor wholly upon taxes, but fiscal administration should be so adjusted as gradually to change the burden of expenditure from credit to clear income." As between the different forms the debt may take, floating debts should be but sparingly used; voluntary loans appeal to the only reliable motive on which to rest a credit policy; bonds are preferable to annuities; and while Government may use its discretion in fixing times of payment, loans should be placed at par rather than at discount. At the close of a war, floating debts should receive immediate attention, and a policy of contraction should be set on foot to meet the case of irredeemable paper notes. In peace management, the financier should have regard to the need of investors in giving shape to the public debt; should be able to work wisely when he comes in contact with the money market, and harmoniously with all laws affecting or affected by his securities; and "should have clear views respecting the policy of conversion." The policy of debt-payment—as opposed to holding on till the indebtedness is overtaken by the growth of the country in wealth—is defended, but it should not be pushed so rapidly as to force the rate of business profit below the rate necessary to sustain industrial hopefulness. The best method of payment is that of making permanent appropriation to the service of the debt, leaving the administration large discretion in its application.

In the third part—"Local Deficit Financiering"—a review of the past experiences and present condition of the States and municipalities in financial management leads up to inquiries into the causes of municipal corruption, and the expediency of limiting the power of cities and States to borrow money. Municipal corruption is regarded as merely a symptom of deep-seated disorder in the body politic, and not a distinct and independent evil. The final explanation of the phenomena is to be found in the fact that the present organization of society does not properly correlate public and private activity. Private business and the service of corporations offer more attractive careers than municipal office, and secure the service of the best men. The remedy for corruption is, then, to enlarge the scope and legitimate emolument of municipal life, so that the best men may also be attracted to it; and this should be supplemented by the enforcement of personal responsibility. While the evils against which the restrictions of the freedom of States and municipalities in financial and industrial matters have been directed, are acknowledged to have been real evils, the method that has been adopted of curing them is believed to have brought great danger to society. In this sphere regard must be had (or our institutions are imperiled) to the two fundamental principles of republicanism: that all concentration of power should be held to strict accountability; and that the exercise of all responsible power should lie as closely as possible to the people upon whom it is to fall. The present standing of private corporations before the law contradicts the first rule; for "these corporations are practically irresponsible to the people by whose favor they exist, and whom they pretend to serve. Popular liberty could be menaced by no greater danger." The growing importance of the Federal Government threatens to disregard the second rule, that responsible power should lie as closely as possible to those upon whom it is exercised. Yet "the financial disabilities under which the States rest have placed them *hors de combat;* and, without some radical modification of existing relations between the various centers of government, the pressure of coming events will inevitably lead to an extension of administrative functions under the direct control of Congress." Moreover, as the country becomes more populous, and its various relations more complex, the functions of government must necessarily extend to continually new objects. The States are the proper center for their exercise, but they are considered as being in no position for performing the duty, having been deprived of the facilities for undertaking it by a series of mistakes. Hence, we have reason to regard with solicitude the next step in the development of the industrial constitution of the United States.

The author has evidently endeavored to view judicially the various questions he has raised, and has given a book full of thoughts which it was well to have presented.

Oil and Natural Gas in Illinois. By Theodore B. Comstock. Pp. 15.

The author in this paper, which was read before the Illinois Engineers' and Surveyors' Association, discusses the probability of finding oil and gas in paying quantities within the limits of the State and the districts in which searching for them will be most hopeful. He believes that the accumulation of oil is connected with certain uplifts of the strata indicating faults, and points out certain lines of such dislocations as regions in which the discovery of oil or gas is more or less probable.

Proceedings and Transactions of the Scientific Association. Meriden, Conn. 1885–'86. Charles H. S. Davis, M. D., Secretary. Pp. 64.

The Association, at the beginning of its sixth year, had one hundred and thirty members. Nine papers were read before it in 1885 and eight in 1886; an excursion was made to the Portland quarries; and among the lecturers in 1886–'87 were Alfred Russel Wallace and Professor Alexander Winchell. The volume of the Transactions contains an account of the *Catopterus gracilis*, a fossil fish found at Little Falls, by Dr. Davis; a study of "the Hanging Hills," as the trap ridge at Meriden is called, by J. H. Chapin, D. D.; "A Notice of Certain Fossil Plants in the Quarries at Durham"; "A List of the Birds of Meriden," by Franklin Platt; "Additional Plants found growing at Meriden," by Mrs. C. B. Kendrick; and a poem on "West Peak, and what it saith," by the Rev. J. T. Pettes.

A Century of Electricity. By T. C. Mendenhall. Boston: Houghton, Mifflin & Co. Pp. 229. Price, $1.25.

In this book Professor Mendenhall has presented within a small compass an account free from technicalities, of the growth of the world's knowledge of electricity and its applications. The frictional electric machine, the Leyden-jar, and Franklin's lightning-rod, represented about all that was known concerning electricity in 1786, when Galvani turned a gastronomic delicacy to account as an instrument for scientific research. Volta's invention of the battery, or "pile," followed within the next decade, and made possible the rapid progress in electrical discovery which followed. Nicholson, Carlisle, Davy, Wollaston, and Daniell, are some of the prominent names of the next few years.

In 1820, Oersted, the son of a Danish



apothecary, who had become Professor of Physics in the University of Copenhagen, discovered the action of a current of electricity on a suspended magnetic needle. Within one week after hearing of Oersted's discovery, Ampère had worked out the fundamental principles on which rests the whole science of electro-dynamics. The credit of discovering that electro-magnets of great power may be made by winding the core with many turns of insulated wire, belongs to an American—Joseph Henry—and the telegraph was first made a permanent commercial success by another American—Professor Morse—although various forms of the needle-telegraph had appeared in Russia, Germany, and England.

Multiplex telegraphy and the use of submarine cables are extensions which followed in due time. With the discoveries of Galvani and Oersted must be ranked another, by Faraday, on which rest "nearly all the more recent and more striking applications of the electric current." This was the discovery of electro-magnetic induction. The dynamo-electric machine, and with it the commercial use of the electric light, were thus made possible. The discovery that the dynamo is reversible, i. e., that it will run as a motor if a current is supplied, opened the way for the next great step, hardly yet consummated, the electric transmission of force. Meanwhile electricity had been set at work in the domain of acoustics also, and that wonderful invention, the telephone, was produced. The development of electrical storage, and the direct production of electricity from heat, belong rather to the coming than to the completed "Century of Electricity."

The Story of Ancient Egypt. By George Rawlinson, with the Collaboration of Arthur Gilman. New York: G. P. Putnam's Sons. Pp. 408. Price, $1.50.

The history of this most ancient of the empires of the earth, with its old and advanced civilization, is here told in a connected, current manner, more satisfactorily than in any other book for popular reading with which we are acquainted. The history of Egypt is in fact hard to present acceptably to the general public. The ancient writers upon whom we once depended were inadequate and contradictory. The modern sources—the recovered monuments and inscriptions—are suggestive as to what the facts may have been, rather than satisfying as to what they were; and the gaps between them are so numerous and so wide as to make a complete restoration of the history still impracticable. Hence wide differences of opinion as to many of the essential features still prevail among those who are equally entitled to be regarded as authorities. Yet great advances have been made in the study, and a large number of the more important facts have been made certain. They are almost enough to give us the clew to the course of the history from the beginning. These facts the authors have sifted from the conjectures and speculations and discussions of controverted points with which the literature respecting ancient Egypt is encumbered, and have presented them in their order, and with reference to their bearing; and they have thus given, in a readable shape, a notion of what is actually known on the subject.

The Story of the Normans. Told chiefly in Relation to the Conquest of England. By Sarah Orne Jewett. New York: G. P. Putnam's Sons. Pp. 373. Price, $1.50.

This is one of the volumes of the happily conceived "Story of the Nations" series, and the one, perhaps, of those which have been published, that possesses the most immediate interest to American readers, as telling of a people through whom, in more than one sense, we partly derive our ancestry and our institutions. The story is presented in the attractive form of a running narrative, in which, while the history is faithfully adhered to and presented in its connection, scope is given for the full play of the romantic features and lively incidents which appear to be inseparable from our conceptions of Norman history, feudalism, and the life of the middle ages.

The Annual Index to Periodicals for 1886. Bangor, Me.: Q. P. Index, Publisher. Pp. 27.

This is the sixth annual issue of this Index and the second in the series of "Cumulative Indexes." It furnishes a complete index for the year to more than twenty-seven periodicals. By a system of notation which, odd as it looks at first, is easily learned and proves to be simple when learned, articles are referred to their authors and authors to their articles, and both to the precise issues of the several magazines in which they appear. Another set of symbols indicates the precise character of the several articles, The whole is put into so compact a shape that the present thin volume contains sixteen hundred and eighty-eight separate entries.

First Book of Chemistry: A Course of Simple Experiments for Beginners at Home and in Primary Schools. By Mary Shaw Brewster. New York: D. Appleton & Co. Pp. 144. Price, 77 cents.

To make the educational influence of the study of chemistry available for young pupils is the object of this little hand-book. In the words of the preface, "It aims to stimulate in the beginner, by the natural method of observation and experiment, a desire to know about every-day phenomena —to lead him to question for himself, and then to answer his own inquiry, not by appealing to book or teacher, but by reference to the facts presented." Generally the pupil is told only how to proceed, and is left to discover the results of experiments by his own observation. Only those experiments are employed whose bearings can be readily comprehended, and which can be performed with utensils and materials found in the homes and stores of any village. But little of chemical theory or nomenclature has been introduced. The pupil is first led to observe the difference between a mixture and a chemical compound, and is further made acquainted with chemical affinity, solution, crystallization, precipitation, filtration, and other fundamental ideas and processes. Then, after a presentation of the properties of acids, bases and salts, the common elements are taken up separately. The book is illustrated, and contains lists of apparatus and materials needed for experiments.

Report of the Ladies' Health Protective Association of New York. 1885–'86. Mrs. M. J. Herbert, Secretary. Pp. 15.

The Association was organized in November, 1884, for the purpose of dealing with some of the "east-side nuisances" of

New York city. It had eleven members at the beginning; at the end of the first year it had more than six hundred members. The ladies seem to have gone into their enterprise with much energy, before which several established nuisances, that had long baffled the political powers, had to give way. Their influence was felt in New Jersey, where they were called on to help remove some offensive conditions, and in the State Legislature, where they labored to prevent damaging legislation.

California State Mining Bureau. Sixth Annual Report of the State Mineralogist. Part I. By Henry G. Hanks. Pp. 145. Part II. By William Irelan, Jr. Sacramento. Pp. 222.

The first part, besides a general statement of the condition of the Bureau and its collections and a reference to the comparative merits of mining and manufacturing as adapted to California, gives a paper on "Building-Stones and Building-Materials in California," with a list of the stones and their localities; a table of altitudes of twelve hundred and ninety-seven points; accounts of the "Mineral Springs of California"; descriptions of "The Calistoga Silver-Mines"; and the geology and mineralogy of San Diego County. The second part contains the special report of the trustees of the Bureau; accounts of a considerable number of mines and of the processes and machinery employed at them; summaries of the mineral products of the United States in 1885; the mining laws of the United States and the departmental interpretations of them; various tables and rules of use in mining; and tables of legal distances and routes of travel in California.

Ottawa Field Naturalists' Club. Transactions No. 7, 1885. W. H. Harrington, President. Ottawa, Canada. Pp. 90.

The Club appears to have enlisted a full representation of the persons within its sphere of action who are interested in its work. Three Club excursions were made, while the sub-excursions were more numerous and more successful than in any previous season. Ten afternoon lectures or classes were held during the winter, on entomology, mineralogy, ornithology, and botany. The fact that six of the meetings were held in educational institutions is regarded as indicating that the Club is being more and more recognized as able and willing to impart instruction in the natural sciences. With the "Transactions" are embodied the special reports of the geological, conchological, entomological, ornithological, and botanical branches of the Club; papers on the "Black Bear," by Mr. W. P. Lett, and "Ottawa Dragon-Flies," by Mr. T. J. MacLaughlin; a "List of Mosses collected near Ottawa," by Professor J. Macoun; and "A New Departure in the Study of Minerals," by the Rev. C. F. Marsan.

Mathematical Teaching and its Modern Methods. By Truman Henry Safford. Boston: D. C. Heath & Co. Pp. 47. Price, 25 cents.

This paper is one of a series of "Monographs on Education," which the publishers have undertaken for the purpose of preserving a class of essays on the theory or practice of teaching which, not being suited for popular magazine articles or voluminous enough for books, are, while they are of great value, in danger of being lost. The thoughts expressed in the paper are such as have been suggested by the author's long practical experience in giving instruction in mathematical subjects, and the conclusions are believed to be in agreement with the views of progressive educators, but not with ordinary traditions. "It is an old complaint against mathematics as a mental discipline," says the author, "that it is too abstract and unpractical. When we look at the ordinary courses in our colleges and schools, we shall find that there is much truth in this; but the complaints are entirely groundless when mathematics takes its proper place in our courses, and is taught in the proper manner." It is the object of the essay to search for the "proper manner."

McCarty's Annual Statistician, 1887. Edited by L. P. McCarty. San Francisco: L. P. McCarty.

The usefulness of well-edited and comprehensive compilations of statistics goes without saying as a valuable *vade mecum* for the editor, politician, scholar, even for professional men and merchants. Of these hand-books we have many more or less complete, but certainly, in respect of volume and mass of information, the book before us is well ahead of its rivals. It includes nearly everything of interest, both as to Europe and America, relating to commerce, industry, agriculture, manufactures, finance, education, politics, and history. Elaborate tables, embodying the latest results, and in many cases comparative tables showing the aggregates of different years from a decade to a half-century, enable one to grasp the growth of each interest at a moment's glance. It may be said that in all such books it is not practicable to secure an orderly and systematic arrangement. Mr. McCarty has met the difficulty as well as possible by giving a very thorough index to the contents. The material seems to have been gathered with great care and industry, and presumably the citations of figures are trustworthy, except so far as errors have crept in through bad proof-reading. Mr. McCarty's plan appears to have been to make this a most exhaustive book of its class, and in the extent of the field he covers he has not fallen short of his aim. It is not easy to overrate the amount of labor essential in the compilation of such a work, and its value to the public is in direct ratio. About one half of the book is devoted to the United States. In addition to statistical matter proper there are about one hundred pages devoted to scientific, mechanical, and commercial facts and formulas.

Thoughts on Science, Theology and Ethics. By John Wilson, M. A. London: Trübner & Co., pp. 197.

"The object of this little book," says the preface, "is to give a correct sketch of the main lines of modern thought in small compass and in language simple enough to be easily understood." This object, it seems to us, has been attained with more than usual success. It is an excellent work to put into the hands of the young who are beginning to think and seeking to learn how to think. The distinction drawn between science and theology with respect to the meaning of the word "God" illustrates the theoretical doctrines of the author. "God," he says, is "the Omnipotent Power which exists behind the facts of the universe. Of this power science asserts the existence to be a necessary supposition, but the nature to be to us unknowable and inconceivable. Theology, on the other hand, asserts its nature to be known, and conceives it to be manlike." This is exceedingly well put. Proceeding from this declaration, the points of opposition between science and theology are made very clear. The necessity of a scientific foundation for ethics is set forth in the second part of the work. The first part treats, in successive chapters of "What is Science?" "What is the Use of Science?" and "The Methods of Science." Part second deals with "The Object and Scope of Ethics," "The Origin and Nature of the Moral Code," and "The Sanction of the Moral Code." We hope this meritorious book will be widely circulated.

VAN NOSTRAND'S SCIENCE SERIES.

No. 90.—Analysis of Rotary Motion, as applied to the Gyroscope. By Major J. G. Barnard, A. M. New York: D. Van Nostrand. Pp. 66. Price, 50 cents.

Major Barnard's analysis, which is here republished, is based on the works of Poison. The author shows first how the particular equations of the gyroscopic motion may be deduced from the general equations of rotary motion, and then points out that the analytical results arrived at contain within themselves the sole clew to the visible phenomenon, and dispel all that is mysterious and paradoxical.

No. 91.—Leveling; Barometric, Trigonometric, and Spirit. By Ira O. Baker, C. E. New York: D. Van Nostrand. Pp. 145. Price, 50 cents.

The matter in this treatise forms a part of the lectures on geodesy given by the author to his classes at the University of Illinois, and is published for the use of his own and other students. The author does not claim that there is anything new or original in the volume; but he has combined in a single book information that heretofore could only be found scattered through many. His object has been to give all that was necessary for a thorough comprehension of the principles involved, and an intelligent understanding of the method of applying them. The attempt has been made to point out all the sources of error, and to give accurate data showing the degree of accuracy attainable by each method of leveling.

No. 92.—Petroleum: Its Production and Use. By Boverton Redwood, F. I. C., F. C. S. New York: D. Van Nostrand. Pp. 210. Price, 50 cents.

The material of this volume is abridged from a series of Cantor lectures given before the Society of Arts, London, and originally published in the journal of the society. The parts omitted are such as were deemed of no interest to American readers. Almost every topic relating to petroleum has been considered, beginning with the kinds of rocks in which petroleum is found, in the United States and in the Baku district, and taking up in succession the chemistry of petroleum, the construction of wells, methods of transporting crude petroleum, the manufacture of commercial products and their transportation, methods of testing oils and paraffine in considerable detail, followed by a sketch of the progress of invention in oil-lamps.

Massage as a Mode of Treatment. By William Murrell, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 100. Price, $1.25.

The attention which has been given recently to massage, in medical books and journals, has excited a demand for a more general introduction of that method of treatment, and for operators. But much ignorance still prevails upon the subject, both among those who require massage and among those who offer themselves as operators. It is too important a matter to be trifled with, and the remedy is too beneficial a one to be neglected when it is practicable to secure its proper application. Hence this little book, telling exactly what massage is, and how it should be applied, and how the operator should be qualified, fills a felt want. It gives the history of massage; an account of the method of performing it, describing particularly the Von Mosengeilian system as practiced in Holland and Germany; chapters on "The Masseur and the Masseuse" (male and female operators) and "The Physiological Action of Massage"; and indications as to the class of cases in which it is most likely to do good. On the last point the author says: "The ignorant rabble of course thinks that it will cure everything, but as a matter of fact its sphere of action is very limited. If carried out under the direction of a scientific physician, who has had experience in this mode of treatment, it yields excellent results; but if allowed to drift into the hands of an ignorant empiric, it soon degenerates into the most arrant quackery."

Profit-Sharing. By N. O. Nelson, St. Louis, Mo. Pp. 40.

This pamphlet is a collection of articles which were written by the author on different occasions, but always by request, holding up the plan of giving to workmen an equitable share in the profits of the business as the true solution of the so-called "labor question." Force is given to the arguments by the fact that the system which the author advocates has been introduced into the manufacturing establishment with which he is connected, and is in successful operation there. Two of the papers are devoted to accounts of the introduction and workings of the plan.

Proceedings of the Department of Superintendence of the National Educational Association, February, 1886. Washington: Government Printing-Office. Pp. 90.

This is published as one of the "Circulars of Information" of the Bureau of Education. More than sixty superintendents and persons actively interested in education attended the meeting. Among the topics considered in papers read and in discussions were, "The Duties of County Superintendents," "Reading Circles for Teachers," "Co-education of the Races," "Educational Statistics," "The Educational and Religious Interests of the Colored People of the South," "Forestry in Education," "Language-Work," "Growth and Benefits of Reading Circles," and "City Superintendence."

The Labor-Value Fallacy. By M. L. Scudder, Jr. Chicago: The Patriots' League. Pp. 112. Price, 10 cents.

This pamphlet is the first of a series to be published by the "Patriots' League"—an association of conservative citizens whose purpose is to combat socialist heresies and their kindred, and to disseminate sound views—and to be sold at cost. Its principal aim is to controvert the dogma of the trades-unions that it is the labor element which determines the exchangeable value of commodities.

Journal of the Elisha Mitchell Scientific Society. 1885–'86. E. P. Venable, Chapel Hill, N. C., Secretary. Pp. 146, with Map. Price, 50 cents.

The report covers the third year of the work of the society, which is also mentioned as the most prosperous year it has enjoyed. Regular monthly meetings of members and invited guests have been held for hearing papers and discussing scientific questions of interest. The feature of public lectures has developed into the University (of North Carolina) Lecture course, continuing through the session. Sixty-one papers were read and presented at the meetings of the society, about one third in number of which are given in the present number of the "Journal." Of these papers two are of very general interest, viz.: "The Sketch of the Life and Scientific Work (in botany) of Lewis David Schweinitz," which is accompanied by a portrait; and Messrs. Wood and McCarthy's "Wilmington (N. C.) Flora," including a list of the plants and date of flowering, and accompanied by a map of Hanover County. A beetle that infests tobacco and cigarettes is described by Mr. G. F. Atkinson.

Economic Equities. A Compend of the Natural Laws of Industrial Production and Exchange. By J. K. Ingalls. New York: The Truth-Seeker Company. Pp. 63. Price, 25 cents.

The author is of opinion that a proper solution of the questions he has in view can not be reached "while deferring to the traditions and institutions of barbarous ages, or to the prejudices and sordid maxims of the very rich and powerful"; or by looking at them from the point of view of employers or of wage-workers as a class. He has sought, impartially, to ascertain the true nature of the relation of earth and man to social industry and reciprocal exchange. The result of his search is an obvious inclination toward the theories of the kind upheld by Henry George.

Elements of English. By George Hodgdon Ricker. Chicago: The Interstate Publishing Company. Pp. 106. Price, 30 cents.

This book is intended to be an introduction to English grammar for the use of schools. It aims to make the branch less difficult, more attractive, and more useful to young pupils. It is designed for the lower grades of schools, and to be preparatory to larger works. It consists of a series of lessons, treating of the parts of speech and their uses, and of the simple sentence in its various forms, which are illustrated by practical exercises composed of words in common use. It also contains lessons on spelling, capital letters, punctuation, directions for letter-writing, the principles of analysis and synthesis; and brief methods of parsing.

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Latham, John, Managing Editor. The "Esoteric." Vol. I, No. 1. Monthly. Boston: Esoteric Publishing Company. Pp. 32. 15 cents. $1.50 a year.

Walker, Francis A. Arithmetic in Primary and Grammar Schools. Pp. 29.—A Plea for Industrial Education in the Public Schools. Pp. 34. Boston: Damrell & Upham.

Hamilton, Dr. A. "The Fonetic Herald." 1886, and January and February, 1887. Monthly. Pp. 4 each number. Port Hope, Ont.

Shufeldt, R. W. Contributions to the Anatomy of Geococcyx Californianus. Pp. 16. With Four Plates. Additional Notes upon the Anatomy of the Trochili, Caprimulgi, and Cypselidæ. Pp. 3.

Blakiston, Son & Co., Philadelphia. New Series of Manuals and Text-Books for Students. Announcement.

Zoölogical Society of Philadelphia. Fifteenth Annual Report. Arthur Erwin Brown, General Superintendent. Pp. 20.

Alabama Weather Service. Report for April, 1887. P. H. Mell, Jr., Director. Auburn, Ala. Pp. 6.

Riley, C. V. Shade-Trees and their Insect Defoliators. Pp. 69.—Reports of Experiments with Various Insecticide Substances. Pp. 34.—Miscellaneous Notes on the Work of the Division of Entomology for the Season of 1885. Pp. 45. With Plates. Washington: Government Printing-Office.

Lighthall, W. Dourr. Sketch of a New Utilitarianism. Montreal: "Witness" Printing-House. Pp. 40.

Mathews, Robert. Competition and Monopoly. Rochester, N. Y. Pp. 14.

D. T. Smith. The Gathering of the Waters; or, The Evolution of Seas and Rivers. Louisville, Ky. Pp. 8.

Newton, James King, Oberlin, Ohio. Obligations of the United States to initiate a Revision of Treaties between the Western Powers and Japan. Pp. 25.

Lloyd, James Hendrie, Philadelphia. The Claim of Moral Insanity in its Medico-Legal Aspects. Pp. 16.

Hayes, Henry. The Story of Margaret Kent. Boston: Ticknor & Co. Pp. 444. 50 cents. (Ticknor's Paper Series.) Weekly, No. 1.

Miller, Annie Jenness, Editor. "Dress." Monthly. Devoted to the Practical and Beautiful in Women's and Children's Clothing, etc. New York: The Gallison and Holborn Company. Vol. I, No. 1. Pp. 34. 15 cents. $1.50 a year.

Mays, Thomas J., M. D., Philadelphia. Does Pulmonary Consumption tend to exterminate the American Indian? Pp. 8.—An Experimental Inquiry into the Chest Movements of the Indian Female. Pp. 11. Detroit, Mich.: George S. Davis.

Morel, Dr. V. New Treatment of the Affections of the Respiratory Organs and of Blood-Poison, by Rectal Injections of Gases. Pp. 21. Also Reprints of Articles on the same, and List of Apparatus. Pp. 18. Philadelphia: James W. Queen & Co.

Jackson, C. Loring, and others. Contributions from the Chemical Laboratory of Harvard College. (Five Papers.)

Chaillé, Stanford E., Tulane University, La. Abuse of Alcoholics by the Healthy. Pp. 36.—Infants; their Chronological Progress. Pp. 20.

Public Health in Minnesota. Red Wing, Minn. State Board of Health. Pp. 8.

Walker, James, Cincinnati. Remarks and Criticisms on Articles about Brewing. Pp. 26.

Bolton, Henry Carrington, Hartford, Conn. Alchemy and Numismatics. Pp. 12.

"Once a Month." A Journal for Young People, Newark, N. J.: Richard W. Bloemeke. Pp. 16. 5 cents. 60 cents a year.

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Halstead, Byron D. Bulletin of the Iowa Agricultural College, from the Botanical Department. Pp. 66.

Plumb, Charles S. "Agricultural Science." Monthly. May, 1887. Geneva, N. Y. Pp. 24. $2 a year.

Bocock, Kemper, Philadelphia. A Plea for Area Taxation. Pp. 32.

Stone, George H., Colorado Springs, Col. Terminal Moraines in Maine. Pp. 8.

Averil, William D., Chestnut Hill, Philadelphia. "The Conchologists' Exchange." Monthly. Pp. 12. 3 cents. 35 cents a year.

Huston, H. A., Director, Lafayette, Ind. The Indiana Signal Service. Pp. 9.

Isms, Material, Occult, and Spiritual, and their Influence in determining the Religion of the Future. Cincinnati: Robert Clarke & Co. Pp. 85. 40 cents.

Beall, F. M. M. "Monthly Weather Review, of United States." March, 1887. Washington City: Signal-Office. Pp. 28.

Bœhmer, George H. List of Astronomical Observatories. Washington: Government Printing-Office. Pp. 14.

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# POPULAR MISCELLANY.

**The Glacial Lake and Island of Cincinnati.**—The city of Cincinnati occupies, as Professor Joseph F. James remarks, one of the most interesting geological positions on the North American Continent. The strata of its hills are almost wholly composed of Lower Silurian fossils, in nearly perfect preservation, packed as closely as they can be stowed together. Besides this, it furnishes most interesting marks of the conditions which prevailed in the region in glacial and pre-glacial times. After the close of the glacial period, in the presence of the *débris* left by the ice-sheet, blocking up in places the beds of the former streams, new channels had to be sought by the water. Many streams were compelled to form entirely new channels, but others had to carve new courses only in places here and there. The Ohio River seems to have been in the latter category, for in many places its valley is too wide and too deep to have been excavated by the volume of water now flowing at ordinary stages. In fact, there seems little doubt that the Ohio flows in a channel which was cut long previous to the glacial period. This old channel has been largely filled up, and the river now flows from thirty-five to forty feet above its ancient bed. This seems to be proved by the discovery, at that depth below the present surface of the ground, of an extensive bed of carbonaceous material consisting of stumps of trees, leaves, seeds, and other vegetable remains. Several facts seem to point to the conclusion that on and near the site of the city was once spread out a sheet of water that assumed almost the aspect of a lake. The outlet of this sheet was not like the present course of the river, past the mouth of Mill Creek, but up what is now Mill Creek Valley on one side, and up the Little Miami Valley and an ancient channel between Red Bank and Plainville on the other side, of what then formed an island now occupied by a part of the hill suburbs of Cincinnati. These ancient channels extended northward on the east and west of the island, and united near where Ludlow Grove now is, and thence together held their way northward to Hamilton; there they turned to the west and south, and reached the Ohio River Valley as it is now, somewhere near Lawrenceburg, Indiana, by following the course now used by the Big Miami. In those days a barrier of land stretched from Price Hill across to the Kentucky side. It is supposed that during the glacial period the end of an immense glacier extended south as far as the Ohio River, and at Cincinnati so completely blocked the channel as to compel the river to seek another course. But at the close of the ice age, and when the glacier had melted, the river attempted to return to its former channels. Finding, however, its old bed filled with sand and gravel, the *débris* of the retired ice-field, and finding, perhaps, that the former impassable barrier had lost some of its height, it beat against it, gradually wore it away, and cut for itself a new channel from the mouth of Mill Creek to Lawrenceburg.

**Natural Gas at Pittsburg.**—From a lecture delivered at the Franklin Institute, December 18, 1886, by Mr. Charles A. Ashburner, Geologist in charge of the State Geological Survey, it appears that there are now six natural gas companies in Pittsburg, managing 107 wells, and supplying the gas through more than 500 miles of pipe, of which 232 miles are in the city proper. The total area of pipe leading into Pittsburg is given as 1,346,608 square inches, and the total capacity of the mines is estimated at more than 250,000,000 cubic feet of gas per day. One company supplies more than 400 manufactories and 7,000 dwellings with all the fuel consumed in them. The composition of the gas varies greatly, but it may be generally described as a mixture of hydrogen, nitrogen, and marsh gas, with occasionally higher carbon compounds. A thousand cubic feet of gas is calculated to equal in heating capacity fifty-five pounds of coal. The use of gas for domestic purposes has been facilitated by the inventions of Mr. Westinghouse, among which are a device for preventing leaks and a pressure-regulator. The gas is furnished to the consumer on a yearly contract with a company for supply at certain rates and costs, to heat and light a house containing twelve rooms for from $70 to $90 a year. With it, every room may be kept at a temperature not varying two degrees, regardless of the condition of the outside temperature, or of pressure on the mains. While the lecturer admitted that the source of natural gas is capable of exhaustion, he did not think there was any imminent danger of such a calamity.

**Origin of the "Second Growth" in Woods.**—The origin of the second growth that springs up after a forest has been cleared away, which is usually different in kind from the previous growth, has given rise to one of the problems that have never been solved. Perhaps the most frequently suggested explanation is that it springs up from seeds that have lain dormant in the ground for centuries; but aside from its being hard to conceive of seeds preserving their vitality for so long a time under the conditions to which they must be exposed, this supposition does not account for the origin of the seeds. Dr. Clevenger, of Chicago, thinks that the soil has been substantially exhausted of the constituents favorable to the growth of the original timber, and has become more suitable for the support of other or complementary sorts; but as against this, evidence of the supposed exhaustion seldom exists, and the origin of the seeds is still unaccounted for. Mr. John T. Campbell, of Rockville, Indiana, a practical woodsman, supposes that while most forest-seeds are not ready to grow in the leaf-fall of the parent tree, other seeds and nuts are transported for long distances and in great numbers by crows, woodpeckers, squirrels, etc., and that these are the seeds from which the new growth arises. This theory must depend largely upon whether nuts are actually transported in such numbers as it requires, by the agencies mentioned. Mr. Campbell adduces an incident that occurred under his own observations, in which, if not the identical thing, something very like it was done.

**Work and Play in Instruction.**—School Superintendent B. A. Hinsdale, of Cleveland, Ohio, remarks, upon a precept laid down by President Eliot in one of his addresses that "a subject is good for a child precisely in proportion to his liking for it, or, in other words, to his taste and capacity for it," that a capital distinction should be made between work and play. The object of education is to learn to do work. This fact should not be lost sight of, even though the road to the end be made to lead, at times, a little way through play. "The child has a spontaneous nature that should be harnessed to studies and to the whole work of life. Automatic attention is that state of the mind in which its energy is given to a thing from some native affinity or attraction; volitional attention, that state in which its energy is given by act of choice. The development of volitional attention is one of the highest results of discipline. Now, in training the child the spontaneous attention must be rallied to the support of the volitional, which is weak or does not at first exist at all, but as time goes on the volitional attention should grow and become more and more independent of the spontaneous. Humor has been likened to the lever, by means of which we raise great weights with a small force. Love and enthusiasm are also powerful motives. There is a large suggestion for the teacher in the fact that a little boy who has complained bitterly of the wearisomeness of walking will, when put astride of his grandfather's cane, and told that it is a horse, scamper away all forgetful of his previous complaints. But somewhat of life consists of walking when one is weary, and no boy is fitted for life who can not walk. The child should indeed be led to the hard by the way of the easy, but the man has no real training or character who can not, on due occasion, collect his powers to do a multitude of things that he considers hard and disagreeable. The spontaneous powers keep us alive in infancy, and death comes when they wholly fail us, but the highest end of education is the fullest development of the judgment, the moral sense, and the will. Hitch the spontaneous forces to your wagon by all means, but, if you have no other horses, you should not be surprised to find that you drive a balky team. . . . It is not true that nothing is good for training that is not hard, but it is true that no training is complete that does not involve much severe and vigorous labor. It is not true that mental exercise is useful only when it is repulsive and distasteful, needing a dead-lift of the will, but it is true that a good many of such 'lifts' have to be made, and the child must be got ready for the lifting. . . . In a word, my whole contention is that the child must be brought, progressively, of course, to measure his full powers with the labors and difficulties of life."

**How the Structure of Rocks is determined.**—Mr. George F. Becker, in a paper pertinent to some differences of opinion between himself and Messrs. Hague and Iddings, of the United States Geological Survey, concerning the rocks of the Washoe district, remarks that, given the chemical constitution of an eruptive magma, the mineralogical results are dependent solely on the physical conditions to which it is subjected. It is not a question, therefore, whether, if similar magmas are subjected at different times to similar temperatures and pressures, similar mineralogical results will ensue, but whether at different geological eras the physical conditions attending the cooling of eruptive masses have been substantially identical. That this has sometimes been the case will scarcely be denied. The problem with which geologists have to deal, however, is not precisely that just stated, for, since the earlier formations have been deeply eroded, while the degradation of comparatively recent rocks is, as a rule, correspondingly small, upper portions of more recent eruptions have to be compared with lower portions of more ancient eruptions. The lithological problem is, therefore, greatly complicated. The main purpose of lithology being, as the author believes, to trace the physical conditions through which a mass of readily ascertainable chemical composition has passed, in the present state of ignorance concerning the effects of temperatures and pressures, the most rational method is to study and record every peculiarity of every occurrence and every perceptible difference between rocks. . . . Rocks can, of course, never be classified with the sharpness of minerals. Rocks are essentially mixtures, and therefore pass into one another insensibly. The wonder is, that rocks not only conform in some degree to a system, but that certain lithological types exhibit such an extraordinary persistence, being met with at the most remote quarters in typical development. While the very nature of things thus excludes a rigid classification of rocks, observation clearly indicates the possibility of reducing them to a natural system.

**Unfounded Fears.**—Something is occasionally said about the expediency of avoiding heavy work in very warm weather. The "Lancet" evidently thinks there has been too much talk of the kind, and expresses views of its own on the matter. It says: "After it has been proved to demonstration that nothing whatever should be done, in schools, particularly, during hot weather, we shall be quite prepared to make common cause with the school-children in the endeavor to demonstrate that it is undesirable to do anything in cold weather either. In short, let us give up eating, drinking, working, playing, sleeping, and living, in the last issue, lest some harm should befall. It is rank nonsense to write and speak, as too many who ought to be better informed are writing and speaking just now, as though every act of existence were beset with peril. It would be better for all of us and the world at large if less ingenuity were spent on the invention of scares, and in the pitiful task of working on the fears of the public."

**Caries of the Teeth.**—Caries of the teeth has been but little investigated scientifically, according to Professor Busch, of Berlin, because in studying it the external hurtful processes have been alone considered, whereas the second important factor, the resisting power of the teeth, has been overlooked. It appears to be peculiar to man, having been observed in no animal; but not to be characteristic of civilized man alone, for it has been observed in large collections of skulls, including those of prehistoric time. Some races are more disposed to it than others. Certain families are particularly predisposed to it. General habit of body has a pronounced influence upon its development, as well as certain peculiarities and crises of physical condition and disease. Disposition to caries shows itself even in the developing tooth in the composition of its enamel, which is undulating, whereas teeth with quite smooth enamel have much greater power of resistance. The enamel appears to be the only tissue in the body which is subject to no metabolism, and which remains quite unchanged. Every alteration in it which is caused by external influences, and every defect of the enamel, remains during the whole of life, and can never be repaired. Dentine also shows differences in structure as regards its disposition to caries. The dentine tubes either run regularly closely side by side, when the teeth have greater power of resistance; or they branch and surround cellular bodies, or even small air-vesicles, when the teeth fall an easy prey to caries. If dentine has been decalcified at any place by the action of acids, it undergoes putrefaction under the influence of bacteria which do not seem to belong to any particular species. Dentine is sensitive, though nerve-filaments have not as yet been traced into it. Actual toothache does not occur in the course of caries until it has reached the pulp. The inflammation of the pulp is particularly violent and painful, because the tissue is so richly provided with blood-vessels and nerve-filaments. As the products of inflammation can not escape, they collect and work their way downward, where they produce the most painful inflammation of the roots and the periosteum. The chief object of the rational treatment of caries of the teeth consists in the removal of every particle of carious substance out of the diseased tooth and the protection of the sound dentine that has been exposed against external injurious influences by covering it with a fine substance which is not attacked by acids —gutta-percha, cement, or gold. Although the dentine is not as unchangeable as enamel, but manifests, by becoming firmer or softer, that it is not quite uninfluenced by tissue-changes, yet its caries is not an irritative process that the dentine takes an active part in, but a passive process, and consequently the removal of all diseased portions and the protection of the non-carious part of the tooth suffices to stay the morbid process completely.

**Cooking by Steam.**—Professor Behrend, of Hohenheim, has described his experiments on the changes produced in the albuminoid matter of various seeds and of potatoes by steaming under high pressure. In a preliminary experiment, the author found that the albuminoids of lupine-seeds underwent considerable decomposition by heating with water under pressure, and that the decomposition was greater as the duration of the heating and the temperature increased. He, therefore, set to work to investigate whether the albumen was dissolved as well as decomposed, and, if so, what the quantitative relations of these changes were in various seeds, and more especially in the raw starch material for the manufacture of alcohol. Yellow lupines, peas, Hungarian maize, dari (*Sorghum tartaricum*), and potatoes in separate lots, nine months dug and just dug, were experimented upon. When the determinations were made, the contents of the flasks, especially when they were very starchy, became viscid and tenacious, like glue, at from 70° to 100° C., and at 130° C. they were almost clear, limpid liquids, with just a few flecks floating about, while, as the heating was continued, the masses became continually darker, the brownness being more or less intense, according as the substance was richer or poorer in nitrogen. It is hence inferred that the brown coloration is the result of the decomposition of nitrogenous substances. In all cases an increase of the soluble nitrogen was observed, especially with lupines and peas. The nitrogenous matter of maize seems less soluble, and not so easily attacked as that of lupines and peas. From the fact that the chief difference observed, after six hours of heating, was in the amounts of the albuminoid dissolved, it was inferred that the solution of albuminoids precedes decomposition, and this was confirmed by subsequent experiment.

**Geographical Conditions and Civilization.**—Mr. H. J. Mackinder shows, in a paper on "The Scope and Methods of Geography," how the distribution of men, their social and political relations, and the elements of their civilization, are determined by factors of physical geography and of geology back of it. "Each successive chapter postulates what has gone before. The sequence of argument is unbroken. From the position of the obstacles and the course of the winds may be deduced the distribution of rain. From the form and distribution of the wrinkle slopes and from the distribution of the rainfall follows the distribution of the drainage system. The distribution of soils is mainly dependent on the rock-structure, and on a consideration of soil and climate follows the division of the world into natural regions based on vegetation." Certain conditions of climate and soil are needed for the aggregation of dense populations. A certain density of population seems necessary to the development of civilization. Again, comparatively undisturbed strata usually underlie wide plains, and wide plains seem specially favorable to the development of homogeneous races, like the Russians and the Chinese. Yet, again, the distribution of animal, vegetable, and mineral products has done much to determine the local characteristics of civilization. An interesting chapter of geography deals with the reaction of man on nature. Man alters his environment, and the action of that environment on his posterity is changed in consequence. The relative importance of physical features varies from age to age according to the state of knowledge and of material civilization. The improvement of artificial lighting has rendered possible the existence of a great community at St. Petersburg. The discovery of the Cape route to India and of the New World led to the fall of Venice. The invention of the steam-engine and the electric telegraph has rendered possible the great size of modern states. It must, however, be always borne in mind that the course of history at a given moment, whether in politics, society, or any other sphere of human activity, is the product not only of environment but also of the momentum acquired, in the past; and, for that reason, changes from what is established are not made so rapidly as they would otherwise be made.

**Education and Work.**—Many persons believe that under the present systems of education, young people are acquiring a distaste for manual labor, and that there is, consequently, danger that the trade and agricultural occupations will be deserted by all but the most inefficient classes of workmen. Much of the experience of English and American society is in favor of this view, and the tendencies in France appear to be in the same direction. As an offset to what may be said in favor of it, the London "Spectator" directs attention to the fact that no dislike of work, even of the roughest character, has appeared among two of the best-educated races. The Scotch, who have been taught for two hundred years, and are now far more thoroughly trained than English national school boys, show no disposition to avoid labor, but are remarkable for persistent and fairly contented industry. The Prussian peasants, "who are as educated as the English will be twenty years hence, work exceedingly hard, and in the country, where their holdings are their own, show none of the resentment at their fate which is manifested in the towns in the form of socialist aspirations. Gardeners, who all over Great Britain are the best instructed of manual laborers, work, more especially when working for themselves, with unusual diligence; and it is matter of constant observation that a laborer who happens by any accident to be a 'bit of a scholar,' can be depended upon when work presses and every man is required. The people of Rome, who can read and write, are far more diligent than the Neapolitans, who can not; and the best workmen in Italy are those who have passed through the army, and so obtained what is practically an education. There seems to be no *a priori* reason why it should be otherwise."

**Anomalies in Human Teeth.**—Professor Busch has described before the Physiological Society of Berlin various anomalies in human teeth. Among them are anomalies in situation, as in case of the horizontal position of a wisdom-tooth, which, pressing against the third molar, produced inflammation in it; the projection of teeth through the alveolar wall of the maxilla on the anterior or posterior side; exchanges of situation between certain teeth; and irregularities in the number of teeth. Among anomalies in structure are enamel pearls, that is, drops of enamel adhering to the roots, and having no connection with the crown. Anomalies of size are rare; enlargements affect the root more frequently than the crown. Anomalies of the root are sometimes seen in curves, but more frequently as variations in the number of roots. Such anomalies are not frequent; for, out of eleven thousand teeth examined, only about one hundred specimens had been found to present them. Swellings of the teeth are still more rare; and no osseous coalescence of the teeth had ever been observed.

**Intelligence of Fish.**—Mr. W. August Carter has been observing the habits and methods of fishes, and has thereby been led to assert that "the more we learn about them the more they shine out as an intelligent, crafty, and ingenious race"; and he is convinced that some fish, at any rate, are capable of understanding and being understood by one another. He has seen a shoal of carp approached while resting by an individual from another part of the pond; when, on its arrival, the entire body of fish, following the lead of the solitary carp, migrated to the other side of the pond whence the visitor came. He has observed fresh-water perch behaving in a similar manner. A further proof of the communicative capabilities of fish is afforded by the manner in which they oftentimes avoid the snares spread for them by men. They not only possess a keen sense of danger, but must have the power of warning one another. Mr. Carter feels confident, from the result of his observations, that coarse fish are able to influence one another, and if this is the case with them, why not with others? "It can not be credited," he says, "that Nature has denied to fish what she has freely bestowed upon all other animals, and therefore I think the further we go into the subject the more we shall realize that the gift of communication has been implanted in the nature of every creature to a greater or less degree."

**A Link between Invertebrates and Vertebrates.**—Mr. W. Baldwin Spencer, of the University Museum, Oxford, in studying the anatomy and histology of the lizard-like reptile *Hatteria punctata*, found on the pineal body and under the parietal foramen, a rounded mass, provided with a well-marked nerve, which is evidently an eye. A depression of the skin of the head occurs immediately above the parietal foramen, but does not lead down to this structure, which is filled up with a plug of connective tissue that is specially dense around the capsule that envelops the eye. The capsule is also filled up behind with connective tissue, in which a blood-vessel, entering with the nerve, divides and ramifies. "It becomes extremely difficult," says the Rev. W. H. Dallinger, remarking on this discovery, "to conjecture what can be the use of so curiously placed, and at the same time so highly complex, an organ; an eye so buried in its capsule and surrounding tissue, and so covered with the skin of the head as to make it almost inconceivable that it can be affected by even the most intense light; an eye placed, moreover, in a position that suggests no advantage to the present organism." It is also placed in the head of animals well endowed with the normal pair of vertebrate eyes; and on examining it in different lizards it is found in different stages of uselessness, in some being quite isolated from the brain, and in others, as in this *Hatteria*, having a distinct nerve-connection with the hinder part of the pineal body. "The inference, therefore, appears inevitable that it is an atrophied organ; an organ which the evolutional modifications of the original animal possessing this single eye have rendered in the course of ages devoid of function and needless; but at the same time, and by this very means, it is indicative of the ancestry of the organism in which it lingers." Its structure is that of the invertebrate eye, being marked by the peculiar feature in which this eye is different from, or opposite in the arrangement of the parts to, that of the vertebrate eye. Its presence suggests an ancient connection between the vertebrates and the tunicates, and their origin in one common stock; and supplies a new and most direct evidence in favor of the doctrine of the evolution of animal life.

**Specimens of Palæolithic Art.**—The river Tardoire in La Charente, France, is famous for the caves along its banks, out of which numerous evidences of occupation by prehistoric man have been collected from time to time. Among the objects which M. Eugène Paignon has recently found in one of the caves is a piece of reindeer-horn, perforated, of the form known as staff of command, which is covered with accurate and spirited engravings, and marked by work of such fineness that it can be seen best with a lens. On one of the faces of the staff is a representation of two seals, one of which is seen entire with its four limbs, the hinder limbs being faithfully rendered, and having five digits on each flap. The size of the tail is exaggerated. The body is covered with very evident hairs. The head is delicately executed, and the snout with its mustaches, the mouth, the eye, and the ear-orifice indicate genuine skill. The other seal is not entirely seen. It is larger and shows the marks of long hair on the neck. In front of the larger seal is a fish which may be a salmon or trout, for it is spotted like those fish, and its ventral fins are attached to the abdomen. Three plant-stems are seen near the fish. The opposite side of the horn is nearly covered with two long and slender animals, one showing its head and the other one the end of its tail. They are probably intended to be seals. On the same side of the horn are three figures of identical form, the meaning of which is not clear, and a figure that may be a hemipterous insect. M. Gaudry has no doubt of the authenticity of this specimen, for he is assured by M. Paignon, who is a lawyer and publicist of repute, and interested in prehistoric studies, that it was found in his presence by his own workmen while digging out the bone-earth from the bottom of the cave.

**"Educating up."**—Dr. Andrew Wilson suggests that we might with advantage dismiss some of the less useful topics from the curriculum of the common schools, and supplant them by other topics of vital interest to every class of the community. Boys and girls, for instance, are frequently kept working at modern languages, drawing, classics, and other branches, when the teaching of physiology, health, and domestic economy would be of infinitely greater advantage to them in after-life. Some people would think this to be educating down, but Dr. Wilson asks: "Is it certain that by limiting the 'extras'—or what are undoubtedly often useless topics in education in so far as the social life of many of the pupils is concerned—we should be educating down at all? In all likelihood we should rather be practicing the reverse procedure. By imparting a knowledge of the laws of health and economy, we should be enabling the teacher to discharge his duties in a fuller and truer sense than before. . . . Individual culture of such subjects lies at the root of all national advance in health and prosperity. As several writers have shown, the remedy for much of the misery and poverty now existent lies in the better use of the hours spent at school."

**An Undulatory Theory of Odors.**—M. P. Leclerc has propounded a theory that odor is, like light and sound, a phenomenon of undulation. He cites in support of his view that many substances, like sulphur and copper, do not emit odors until they are rubbed, and it is more reasonable to suppose that the rubbings cause undulations than that under that condition the substances emit matter which can not be detected except as a smell. Again, arsenious acid when thrown upon a burning coal, gives out thick gray fumes and an odor of garlic. In the solid state it has no smell, and no more in the vaporous state if no chemical change takes place in volatilizing it. But, when it is thrown upon the hot coal, a reduction takes place to arsenic, that is volatilized and then reoxidized on coming in contact with the air, and we have a smell accompanying the chemical action the same as in many other cases we have light or heat in connection with it. M. Leclerc, continuing his experiments with a rather imperfect instrument, claims to have produced interference of odors analogous with the interference phenomena of light.

**Some British Weeds.**—British farms and gardens are troubled by about a hundred and thirty species of weeds, annuals and perennials, with about a dozen biennials. Among the most troublesome and mischievous of them are the bind-weeds and the couch-grass, which will start to grow from so small a piece of root that it is almost impossible to get rid of them. The couch-grass is nearly in place in Italy, where the white, underground stems, which contain a considerable quantity of starch, are gathered and taken to market, to be sold as food for cattle and horses. A variety of this grass, called matt-grass, also finds a place in Holland, where it is put to use for binding together the sandy dunes and flats by the sea. Some weeds have a marvelous power of increase. The history of the ox-eye daisy in this country illustrates this property. Some seeds of the plant found their way in packages to the Island of Colonsay, in the west of Scotland; in the course of a few years the ox-eye had taken possession of the whole island. The common yellow toad-flax was introduced as a garden-flower by a Mr. Ranstead, and is known as the Ranstead weed. Chickweed is said to have been introduced as a bird-seed. The Scotch thistle arrived in a bed-tick filled with its down. The down, having been replaced with feathers, was thrown away, and soon found a congenial home. Some American plants, particularly the water-weed (*Anacharsis alsinastrum*), have naturalized themselves in Europe, and are becoming troublesome. All weeds are capable of being made useful as manure by plowing them in while they are green and before they have seeded.

# NOTES.

A new feature in the summer courses in chemistry at the Harvard University Laboratory this year, will be a course comprising the work required in preparing for the admission examination in chemistry for the freshman class at Harvard College. It is based on Professor Cooke's recent pamphlet, and is offered to students and to teachers in preparatory schools. The usual courses in general chemistry, qualitative and quantitative analysis, and organic chemistry, will be given, and possibly a course in mineralogy. The courses will be under the direction of Arthur M. Comey, Ph. D., and will open July 11th and close August 20th. A course in practical botany, designed specially for teachers, will be given at the Harvard Botanical Garden, from July 6th to August 6th, under the direction of Professor Goodale. Further particulars will be furnished by the assistant in botany, Mr. J. E. Humphrey, No. 6 Divinity Hall, Cambridge, Massachusetts. All these courses are open to women. The total number of students in the chemical courses last summer was forty-three, and in the botanical course thirty-three.

M. Chevreul, one hundred years and eight months old, presented to the French Academy of Sciences, on the 9th of May, a memoir by M. Arnaud, recording the constant presence of the red-coloring alkaloid, carotine, in the leaves of all plants. The illustrious "dean of the students," whom M. Stanislas Meunier does not recollect to have ever seen "more alert, more enthusiastic in the exposition of natural truths, or more youthful in action," insisted on the precise character of the paper, and emphasized the association of chlorophyl with this substance of complementary color to its own. At the end he promised to revert to the subject and to discuss some other points in a future memoir.

It seems probable that for any further increase of speed in steam-vessels we must rely upon the engineer rather than upon the naval architect. The lines upon which our fastest ships are built can hardly be improved upon; but in the matter of power there is still an enormous waste. It is estimated that only one half of the total power exerted by the engines is effective in propelling the vessel. In addition to this, a very considerable portion of the heat-energy of the fuel escapes through the funnel instead of producing steam. Attention is now given to economizing in these matters as well as in the space allotted to engines, boilers, and fuel. The separation of freight from passenger traffic, after the system pursued on railroads, is destined to be an important factor in facilitating the construction of passenger-vessels of increased speed.

According to Dr. Charles H. Burnett, of Philadelphia, the use of properly constructed ear-trumpets improves the hearing permanently as well as aids it for the time. The cause of deafness being usually anchylosis produced by a catarrhal thickening of the mucous membrane of the auditory parts, passive motion overcomes the immobility that has been induced in them. The form of passive motion which acts most naturally here is that of sound. This form of passive motion, augmented as it is by means of the ear-trumpet, acting frequently and systematically upon the ear, prevents further anchylosis, and the fatty degeneration of the auditory nerve that comes from desuetude. This, of course, tends to a permanent improvement of the hearing, and in some cases patients come to hear without the trumpet.

Preparations for the New York meeting of the American Association, to begin August 10th, are being carried vigorously forward. The President of the Local Committee of Arrangements is Dr. F. A. P. Barnard, the local treasurer is General Thomas L. James, and the local secretary is Professor H. L. Fairchild, Columbia College, New York. The Vice-Presidents are Chauncey M. Depew, Mayor Abram S. Hewitt, George William Curtis, Vice-Chancellor Henry M. MacCracken, Professor J. S. Newberry, Morris K. Jesup, and Judge Charles P. Daly. The whole committee numbers nearly five hundred. There is a large Ladies' Committee, of which Mrs. A. S. Hewitt is chairman, Mrs. Nicholas Fish, first member; Miss Winifred Edgerton, secretary; and Mrs. Sylvanus Reed, treasurer. The sessions of the Association will be held at Columbia College, where the rooms are ample for the several sections. A number of receptions and excursions have been spoken of already, but nothing definite can be said about these until the sub-committees report. The outlook is very promising, and the hope is indulged that the New York meeting will be the most successful in the history of the Association.

M. de Quatrefages and M. H. Chevalier have given their adhesion to the theory, which is taught, as to the Aryan race, in its earliest records, that the migrations of peoples in remote antiquity were provoked by the gradual increase of cold in the northern regions.

An International Conference on Celestial Photography held its meetings in Paris from April 16th to the 25th. A large number of countries were represented by eminent astronomers. Of the nearly sixty persons of whom the congress was composed, three were accredited to America. The conference was opened by M. Flourens, who said that a new era was opening for physical astronomy as well as for mathematical astronomy, and that the photographers were writing the first authentic page of the transformations and modifications of cosmic matter, or of the history of the universe. Admiral Mouchez was elected honorary president, and Mr. Struve, of Pulkowa, effective president of the body. The secretaries were M. Tisserand, of the Collége de France, and Mynheer Vande Sande Bakhuyzen, of Leyden.

The latest census of horses gives the whole number in Europe and the two Americas as 54,850,000. Of these the United States has 9,500,000, and Canada 2,624,000.

The one hundredth anniversary of the death of Père Boscovitch, a celebrated physicist of the last century, was celebrated at Ragusa, his native city, on the 13th of February. He was the author of seventy-six volumes, one for each year of his life. He is said to have been the originator of the doctrine of the centers of forces; he wrote a Latin poem on eclipses; he superintended the repairs of St. Peter's Church under Pope Benedict XIV, by which that cathedral was saved from ruin. He was appointed naval optician by King Louis XVI of France, and was intrusted by Napoleon with the measurement of the degree in Lombardy.

Dr. J. Uffelmann asserts, in the "Archiv. für Hygiene," that the proportion of nutritive material in the edible mushrooms has been overestimated, and that those plants are comparatively difficult of digestion.

An international cremation conference is to be held in Milan in September of this year. Among the questions to which its attention will be brought will be those of legislation concerning the transportation of bodies from one country to another; cremation and the preservation of ashes, with especial reference to hygiene and legal medicine; the technical, moral, hygienic, and economical aspects of different systems of cremation; and projects for international legislation with reference to liberty at funerals.

Dr. R. W. Shufeldt has recorded an interesting study of a case of the repair of the bill of a raven after it had been shot off. The ball had carried away the upper bill just forward of the nostrils. The bone had grown again so as to cover the injury, and the horny covering, following suit, had incased the stump formed by the bone. The result of Nature's surgery in the case was, that the injured part was left in such a condition that the danger of subsequent inflammation was avoided, while the form of the resulting stump was as useful a one as could possibly be expected to follow after a wound of such a character.

## OBITUARY NOTES.

M. Bernard Studer, formerly professor in the University of Berne, Switzerland, died in that city May 2d, aged ninety-three years. He was called the dean of the geologists of Europe.

M. Gosselin, President of the French Academy of Sciences, died April 30th. He was born on the eve of the battle of Waterloo, and was consequently in his seventy-second year. He was distinguished as a surgeon.

Dr. E. Félix A. Vulpian, a famous French physician and Dean of the Faculty of the Academy of Medicine, died May 18th, in the sixty-first year of his age. He became Professor of Pathological Anatomy in 1867, and was the author of important works on the nervous system and its diseases.

Mr. William Cameron, explorer and geologist to the Government of the Straits Settlements (Malacca), died in the latter part of last year, aged fifty-three years. He had been engaged lately in mapping and exploring the unknown parts of the native states. He was well known throughout those states, especially among the Malays and Sakies, of whose language and customs he had an accurate knowledge, and over whom he had great influence.

On the 13th of April occurred the death of Herr J. B. Obernetter, who was well known for his researches in photographic chemistry, at the age of forty-seven years; and on the 14th was announced the death of Dr. Nathaniel Lieberkühn, Professor of Anatomy at the University of Marburg, in the sixty-sixth year of his age.

M. J. B. J. D. Boussingault, chemist and investigator in scientific agriculture, died in Paris, May 12th, aged eighty-five years. He spent several years of the earlier part of his adult life in scientific investigations in South America. Having returned to France, he was appointed Professor of Chemistry at Lyons, and afterward to the chair of Agriculture at the Conservatoire des Arts et Métiers. He was the author of a book and of numerous papers on agricultural chemistry and physiology.

PAUL GERVAIS.

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# THE ECONOMIC DISTURBANCES SINCE 1873.

By Hon. DAVID A. WELLS, LL. D.

II.

WHEN the historian of the future writes the history of the nineteenth century he will doubtless assign to the period embraced by the life of the generation terminating in 1885, a place of importance, considered in its relations to the interests of humanity, second to but very few, and perhaps to none, of the many similar epochs of time in any of the centuries that have preceded it; inasmuch as all economists who have specially studied this matter are substantially agreed that, within the period named, man in general has attained to such a greater control over the forces of Nature, and has so compassed their use, that he has been able to do far more work in a given time, obtain a much larger product, "measured by quantity in ratio to a given amount of labor," and reduce the effort necessary to insure a comfortable subsistence in a far greater measure, than it was possible for him to accomplish twenty or thirty years anterior to the time of the present writing. In the absence of sufficiently complete data, it is not easy, and perhaps not possible, to estimate accurately, and specifically state the average saving in time and labor in the world's work of production and distribution that has been thus achieved. In a few departments of industrial effort the saving in both of these factors has certainly amounted to seventy or eighty per cent; in not a few to more than fifty per cent.* Mr. Edward Atkinson, who has

* According to the United States Bureau of Labor (report for 1886), the gain in the power of production in some of the leading industries of the United States "during the past fifteen or twenty years," as measured by the "displacement of the muscular labor" formerly employed to effect a given result (i. e., amount of product), has been as follows: In the manufacture of agricultural implements, from 50 to 70 per cent; in the manufacture of shoes, 80 per cent; in the manufacture of carriages, 65 per cent; in the

made this matter a special study, considers one third as the minimum average that can be accepted for the period above specified.* Other authorities are inclined to assign a considerably higher average. The deductions of Mr. William Fowler, Fellow of University College, London, are to the effect that the saving of labor since 1850 in the production of any given article amounts to forty per cent; † and the British Royal Commission (minority report, 1886) characterizes the amount of labor required to accomplish a given amount of production and transport at the present time as "*incomparably* less" than was requisite forty years ago, and as "being constantly reduced."

But be this as it may, out of such results as are definitely known and accepted have come tremendous industrial and social disturbances, the extent and effect of which—and more especially of the disturbances which have culminated, as it were, in later years—it is not easy to appreciate without the presentation and consideration of certain typical and specific examples. To a selection of such examples, out of a large number that are available, attention is accordingly next invited.

Let us go back, in the first instance, to the year 1869, when an event occurred which was probably productive of more *immediate* and serious economic—industrial, commercial, and financial—changes than any other event of this century, a period of extensive war excepted. That was the opening of the Suez Canal. Before that time, and since the discovery by Vasco da Gama, in 1498, of the route to India by the Cape of Good Hope, all the trade of the Western hemisphere with the Indies and the East toiled slowly and uncertainly around the Cape, at an expenditure in time of from six to eight months for the

manufacture of machines and machinery, 40 per cent; in the silk-manufacture, 50 per cent, and so on.

* In a print-cloth factory in New England, in which the conditions of production were analyzed by Mr. Atkinson, the product per hand was found by him to have advanced from 26,531 yards, representing 3,382 hours' work in 1871, to 32,391 yards, representing 2,695 hours' work in 1884—an increase of 22 per cent in product, and a decrease of 20 per cent in hours of labor. Converted into cloth of their own product, the wages of the operatives in this same mill would have yielded them 6,205 yards in 1871, as compared with 9,737 yards in 1884—an increase of $56\frac{93}{100}$ per cent. During the same period of years the prices of beef, pork, flour, oats, butter, lard, cheese, and wool in the United States declined more than 25 per cent.

A like investigation by the same authority of an iron-furnace in Pennsylvania showed that, comparing the results of the five years from 1860 to 1864 with the five years from 1875 to 1879, the product per hand advanced from 776 tons to 1,219 tons; that the gross value of the product remained about the same; that the number of hands was reduced from 76 to 71; and that consumers gained a benefit of reduction in price from $27.95 per ton to $19.08.

† "Wages have greatly increased, but the cost of doing a given amount of work has greatly decreased, so that five men can now do the work which would have demanded the labor of eight men in 1850. If this be correct, the saving of labor is 40 per cent in producing any given article."—*Appreciation of Gold*, William Fowler, *Fellow of University College, London, 1886.*

round voyage. The contingencies attendant upon such lengthened voyages and service, as the possible interruption of commerce by war, or failure of crops in remote countries, which could not easily be anticipated, required that vast stores of Indian and Chinese products should be always kept on hand at the one spot in Europe where the consumers of such commodities could speedily supply themselves with any article they required; and that spot, by reason of geographical position and commercial advantage, was England. Out of this condition of affairs came naturally a vast system of warehousing *in* and distribution *from* England, and of British banking and exchange. Then came the opening of the canal. What were the results? The old transportation had been performed by ships, mainly sailing-vessels, fitted to go round the Cape, and, as such ships were not adapted to the Suez Canal, an amount of tonnage, estimated by some authorities as high as two million tons, and representing an immense amount of wealth, was virtually destroyed.* The voyage, in place of occupying from six to eight months, has been so greatly reduced that steamers adapted to the canal now make the voyage from London to Calcutta, or *vice versa*, in less than thirty days. The notable destruction or great impairment in the value of ships consequent upon the construction of the canal did not, furthermore, terminate with its immediate opening and use; for improvements in marine engines, diminishing the consumption of coal, and so enabling vessels not only to be sailed at less cost, but also to carry more cargo, were, in consequence of demand for quick and cheap service so rapidly effected, that the numerous and expensive steamer constructions of 1870–'73, being unable to compete with the constructions of the next two years, were nearly all displaced in 1875–'76, and sold for half, or less than half, of their original cost. And within another decade these same improved steamers of 1875–'76 have, in turn, been discarded and sold at small prices as unfit for the service of lines having an established trade, and replaced with vessels fitted with the triple-expansion engines, and saving from eighteen to twenty-five per cent in the consumption of fuel. To which may be added that an iron cargo-steamer of 2,000 tons, which even as late as 1883 cost £24,000 ($120,000) in Great Britain to build, can now (1887) be built with all the modern improvements for about £14,000 ($70,-000). In all commercial history, probably no more striking illustration can be found of the economic principle that nothing more clearly marks the rate of material progress than the rapidity with which what is old and has been considered wealth is destroyed by the results of new inventions and discoveries.

Again, with telegraphic communication between India and China

* "The canal may therefore be said to have given a death-blow to sailing-vessels, except for a few special purposes."—From a paper by Charles Magniac, indorsed by the "London Economist" as a merchant of eminence and experience, entitled to speak with authority, read before the Indian Section of the London Society of Arts, February, 1876.

and the markets of the Western world, permitting the dealers and consumers of the latter to adjust to a nicety their supplies of commodities to varying demands, and with the reduction of the time of the voyage to thirty days or less, there was no longer any necessity of laying up great stores of Eastern commodities in Europe; and with the termination of this necessity, the India warehouse and distribution system of England, with all the labor and all the capital and banking incident to it, substantially passed away. Europe, and to some extent the United States, ceased to go to England for such supplies. If Austria wanted anything of Indian product, it stopped *en route*, by the Suez Canal, at Trieste; if Italy, at Venice or Genoa; if France, at Marseilles; if Spain, at Cadiz. As a rule, also, stocks of Indian produce are now kept, not only in the countries, but at the very localities of their production, and are there drawn upon as they are wanted for immediate consumption, with a greatly reduced employment of the former numerous and expensive intermediate agencies.* Thus, a Calcutta merchant or commission agent at any of the world's great centers of commerce contracts through a clerk and the telegraph with a manufacturer in any country—it may be half round the globe removed—to sell him jute, cotton, hides, spices, cutch, linseed, or other like India produce.† An inevitable steamer is sure to be in an Eastern port, ready to sail upon short notice; the merchandise wanted is bought by tele-

* In illustration of this curious point, attention is asked to the following extract from a review of the trade of British India, for the year 1886, from the "Times," of India, published at Bombay: "What the mercantile community"—i. e., of Bombay—"has suffered and is suffering from, is the very narrow margin which now exists between the producer and consumer. Twenty years ago the large importing houses held stocks, but nowadays nearly everything is sold to arrive, or bought in execution of native orders, and the bazaar dealers, instead of European importers, have become the holders of stocks. The cable and canal have to answer for the transformation; while the ease with which funds can be secured at home by individuals absolutely destitute of all knowledge of the trade, and minus the capital to work it, has resulted in the diminution of profits both to importers and to bazaar dealers."

† Familiar as are the public generally with the operations of the telegraph and the changes in trade and commerce consequent upon its submarine extension, the following incident of personal experience may present certain features with which they are not acquainted: In the winter of 1884 the writer journeyed from New York to Washington with an eminent Boston merchant engaged in the Calcutta trade. Calling upon the merchant the same evening, after arrival in Washington, he said: "Here is something, Mr. ——, that may interest you. Just before leaving State Street, in Boston, yesterday forenoon, I telegraphed to my agent in Calcutta, 'If you can buy hides and gunny-bags at — price, and find a vessel ready to charter, buy and ship.' When I arrived here (Washington), this afternoon (4 P. M.), I found awaiting me this telegram from my partner in Boston, covering another from Calcutta, received in answer to my dispatch of the previous day, which read as follows: '*Hides and gunny-bags purchased, vessel chartered, and loading begun.*'"

Here, then, as an every-day occurrence, was the record of a transaction on the other side of the globe, the correspondence in relation to which traveled a distance equivalent to the entire circumference of the globe, all completed in a space of little more than twenty-four hours!

graph, hurried on board the ship, and the agent draws for the price agreed upon, through some bank, with the shipping documents. In four weeks, in the case of England, and a lesser time for countries intermediate, the shipment arrives ; the manufacturer pays the bill, either with his own money or his banker's; and, before another week is out, the cotton and the jute are going through the factory ; the linseed has been converted into oil, and the hides are in the tannery being transformed into leather. What has happened in the case of East India produce seems also likely to happen in the case of the great product of Australia—namely, wool—which for many years has been shipped mainly to London for sale and distribution. For with the increased facilities and reduction in the cost of travel and transportation by the Suez Canal route, the tendency in recent years has been to transfer the market for this wool to the country of its growth ; as European Continental, and to some extent American, manufacturers are finding out that by this new arrangement they can have their raw material delivered to them within two or three months of the time of purchase, instead of three or four from the date of shipment to London, and at the same time avoid, to a considerable extent, the "profits" and the "corners" of middle-men and speculators. Under these circumstances the day is probably not far distant when the whole wool-crop of Australia, like the cotton-crop of the United States, will be sold before shipment ; and another long-established "course" of trade, which has brought buyers from all the world to London will be broken up, to the temporary injury and loss of some, but to the greater advantage of the many. And in anticipation of this change, the largest warehouses in the world, some covering an area of five acres, have recently been erected in Melbourne, Sydney, and other Australian cities.

Importations of East Indian produce are also no longer confined in England and other countries to a special class of merchants ; and so generally has this former large and special department of trade been broken up and dispersed, that extensive retail grocers in the larger cities of Europe and the United States are now reported as drawing their supplies direct from native dealers in both China and India.

Another curious and recent result of the Suez Canal construction, operating in a quarter and upon an industry that could not well have been anticipated, has been its effect on an important department of Italian agriculture—namely, the culture of rice. This cereal has for many years been a staple crop of Italy, and a leading article of Italian export—the total export for the year 1881 having amounted to 83,598 tons, or 167,196,000 pounds. Since the year 1878, however, rice grown in Burmah and other parts of the far East has been imported into Italy and other countries of Southern Europe in such enormous and continually increasing quantities, and at such rates, as to excite great apprehensions among the growers of Italian rice, and largely diminish its exportation—the imports of Eastern rice into Italy alone having increased from 11,957 tons in 1878 to nearly 70,000 tons in 1883.

That the same causes are also exerting a like influence upon the marketing of the cereal crops of the United States is shown by the circumstance that the freight rates on the transport of grain from Bombay to England, by way of the Suez Canal, have declined from 32·5 cents per bushel in 1880, to 16·2 cents in 1885; and to the extent of this decline has the ability of the Indian ryot to compete with the American grain-grower, in the markets of Europe, been increased.

How great was the disturbance occasioned in the general prices of the commodities that enter into Eastern commerce by the opening of the Suez Canal, and how quickly prices respond to the introduction of improvements in distribution, is illustrated by the following experience: The value of the total trade of India with foreign countries, exclusive of its coasting-trade, was estimated at the time of the opening of the canal in 1869, at £105,500,000 ($527,500,000). In 1874, however, the value was estimated at only £95,500,000, or at a reduction of ten per cent; and the inference might naturally have been that such a large reduction as ten millions sterling ($50,000,000) in five years, with a concurrent increase in the world's population, could only indicate a reduction of quantities. But that such was not the case was shown by the fact that 250,000 tons more shipping was employed in transporting commodities between India and foreign countries in 1874 than in 1869; or, that while the value of the trade, through a reduction of prices had notably declined during this period, the quantities entering into trade had so greatly increased during the same time, that 250,000 tons more shipping (mainly steam, and therefore equivalent to at least 500,000 more tons of sail) were required to convey it.

In short, the construction of the Suez Canal completely revolutionized one of the greatest departments of the world's commerce and business; absolutely destroying an immense amount of what had previously been wealth, and displacing or changing the employment of millions of capital and thousands of men; or, as the London "Economist" has expressed it, "so altered and so twisted many of the existing modes and channels of business as to create mischief and confusion" to an extent sufficient to constitute one great general cause for a universal commercial and industrial depression and disturbance.

The deductions from the most recent tonnage statistics of Great Britain come properly next in order for consideration. During the ten years from 1870 to 1880, inclusive, the British mercantile marine increased its movement, in the matter of foreign entries and clearances alone, to the extent of twenty-two million tons; or, to put it more simply, the British mercantile marine exclusively engaged in foreign trade did so much more work within the period named; and yet the number of men who were employed in effecting this great movement had decreased in 1880, as compared with 1870, to the extent of about three thousand (2,990 exactly). What caused this? The introduction of steam hoisting-machines and grain-elevators upon the wharves and docks, and the employment of hydraulic appliances and steam-power upon the vessels for steering, raising the sails and anchors, pumping, and discharging the cargo; or, in other words, the ability, through the increased use of steam and improved machinery, to carry larger cargoes in a shorter time, with no increase—or, rather, an actual decrease—of the number of men employed in sailing or managing the vessels.

Statistical investigations of a later date furnish even more striking illustrations to the same effect from this industrial specialty. Thus, for 1870, the number of hands actually employed for every 1,000 tons capacity, entered or cleared, of the British steam mercantile marine, is reported to have been 47, but in 1884 it was only 28; or seventy per cent more manual labor was required in 1870 than in 1884 to do the same work. In sailing-vessels the change, owing to a lesser degree of improvement in the details of navigation, has been naturally smaller, but nevertheless considerable; 28 hands being required in 1884 as against 33 in 1870 for the same tonnage entered or cleared; to which it may be added that if in these comparisons the tonnage of freight actually transported had been taken, in place of tonnage entered and cleared, whether light, partially, or fully loaded, the difference in the labor required for maritime transportation in favor of 1884 would undoubtedly have been even greater. Another fact of interest is, that the recent increase in the proportion of large vessels constructed has so greatly increased the efficiency of shipping, and so cheapened the cost of sea-carriage, to the advantage of both producers and consumers, that much business that was before impossible has become quite possible. Of the total British tonnage constructed in 1870, only six per cent was of vessels in excess of 2,000 tons burden; but in 1884 fully seventeen per cent was of vessels of that size, or larger. Meanwhile, the cost of new iron ships has been reduced, in Great Britain, from $90 per ton in 1872–'74, to $65 in 1877, $60 in 1880, and less than $40 in 1885–'86. Prior to about the year 1875, ocean-steamships had not been formidable as freight-carriers. The marine engine was too heavy, occupied too much space, consumed too much coal. For transportation of passengers, and of freight having large value in small space, they were satisfactory; but for performing a general carrying trade of the heavy and bulky articles of commerce, they were not satisfactory. A steamer of the old kind, capable of carrying 3,000 tons, might sail on a voyage so long that she would be compelled to carry 2,200 tons of coal, leaving room for only 800 tons of freight; whereas, at the present time, a steamer with the compound engines, and all other modern improvements, can make the same voyage and practically reverse the figures—that is, carry 2,200 tons of freight with a consumption of only 800 tons of coal. How, under such circumstances, the charge for sea-freights on articles of comparatively high value has been reduced, is shown by the fact that the ocean transport of fresh meats from New York to Liverpool does not exceed 1 cent ($\frac{1}{2}d.$) per pound; and including commissions, insurance, and all other items of charge, does not exceed 2 cents (1*d.*) per pound. Boxed meats have also been carried from Chicago to London as a regular business for 50 cents per 100 pounds. In 1860 6*d.* (12 cents) per bushel was about the lowest rate charged for any length of time for the transportation of bulk grain from New York to Liverpool, and for a part of that year the rate ran up as high as $13\frac{1}{2}d.$ (27 cents) per bushel. But for the year 1886 the average rate for the same service was $2\frac{1}{2}d.$ (5 cents) per bushel. In like manner, the cost of the ocean transportation of tea from China and Japan, or sugar from Cuba, or coffee from Brazil, has been greatly reduced by the same causes.

The above are examples on a large scale of the disturbing influence of the recent application of steam to maritime industries. The following is an example drawn from comparatively one of the smallest of the world's industries, prosecuted in one of the most out-of-the-way places: The seal-fishery is a most important industrial occupation and source of subsistence to the poor and scant population of Newfoundland. Originally it was prosecuted in small sailing-vessels, and upward of a hundred of such craft, employing a large number of men, annually left the port of St. John's for the seal-hunt. Now few or no sailing-vessels engage in the business; steamers have been substituted, and the same number of seals are taken with half the number of men that were formerly needed. The consequence is, a diminished opportunity for a population of few resources, and to obtain "a berth for the ice," as it is termed, is now considered as a favor.

Is it, therefore, to be wondered at, that the sailing-vessel is fast disappearing from the ocean; that good authorities estimated in 1886 that the tonnage then afloat was about twenty-five per cent in excess of all that was needed to do the then carrying-trade of the world; and that ship-owners everywhere have been unanimously of the opinion that the depression of industry is universal?

Great, however, as has been the revolution in respect to economy and efficiency in the carrying-trade upon the ocean, the revolution in the carrying-trade upon land during the same period has been even greater and more remarkable. Taking the American railroads in general as representative of the railroad system of the world, the average charge for moving one ton of freight per mile has been reduced from about 2·5 cents in 1869 to 1·05 in 1885; or, taking the results on one of the standard roads of the United States (the New York Central) from 1·95 in 1869 to 0·68 in 1885. To grasp fully the meaning and significance of these figures, their method of presentation may be varied by saying that two thousand pounds of coal, iron, wheat, cotton, or other commodities, can now be carried on the best managed railways for a distance of one mile, for a sum so small, that outside of China it would be difficult to find a coin of equivalent value to give to a boy as a reward for carrying an ounce package across a street, even if a man or boy could be found in Europe or the United States willing to give or accept so small a compensation for such a service.

The following ingenious method of illustrating the same results has been also suggested: The number of miles of railroad in operation in various parts of the world in 1885 was probably about 300,000. Reckoning their capacity for transportation at a rate not greater than the results actually achieved in that same year in the United States, it would appear that the aggregate railroad system of the world could easily have performed work in 1885 equivalent to transporting 120,000,000,000 tons one mile. "But if it is next considered that it is a fair day's work for an ordinary horse to haul a ton 6·7 miles, year in and year out, it further appears that the railways have added to the power of the human race, for the satisfaction of its desires by the cheapening of products, a force somewhat greater than that of a horse working twelve days yearly for every inhabitant of the globe." Less than a half a century ago, the railroad was practically unknown.* It is, therefore, within that short period that this enormous power has been placed at the disposal of every inhabitant of the globe for the cheapening of transportation to him of the products of other people and countries, and for enabling him to market or exchange to better advantage the results of his own labor or services. As the extension of the railway system has, however, not been equal in all parts of the world—less than 25,000 miles existing, at the close of 1884, in Asia, Africa, and Australia combined—its accruing benefits have not, of course, been equal. And while all the inhabitants of the globe have undoubtedly been profited in a degree, by far the greater part of the enormous additions that have been made to the world's working force through the railroad since 1840, have accrued to the benefit of the people of the United States, and of Europe—exclusive of Russia, Turkey, and the former Turkish provinces of Southeastern Europe—a number not much exceeding two hundred millions, or not a quarter part of the entire population of the globe. The result of this economic change has therefore been to broaden and deepen rather than diminish the line of separation, between the civilized and the semi-civilized and barbarous nations.

Now, while a multiplicity of inventions and of experiences have contributed to the attainment of such results under this railroad system of transportation, the discovery of a method of making *steel cheap*

* As late as 1840 there were in operation only about 2,860 miles of railway in America, and 2,130 in Europe, or a total of 4,990 miles. For practical purposes, it may therefore be said that the world's railway system did not then exist; while its organization and correspondence for doing full and efficient work must be referred to a much later period.

was the one thing which was absolutely essential to make them finally possible; inasmuch as the cost of frequently replacing rails of iron would have entailed such a burden of expenditure as to have rendered the present cheapness of railway transportation utterly unattainable. And it is most interesting to note how rapidly improvements in processes have followed the discovery of Bessemer, until, on the score of relative first cost alone, it has become economical to substitute steel for iron in railroad construction.* In 1873 Bessemer steel in England, where its price has not been enhanced by protective duties, commanded $80 per ton; in 1886 it was profitably manufactured and sold in the same country for less than $20 per ton! Within the same time the annual producing capacity of a Bessemer converter has been increased fourfold, with no increase but rather a diminution of the involved labor; and by the Gilchrist-Thomas process, four men can now make a given product of steel in the same time and with less cost of material than it took ten men ten years ago to accomplish. A ton of steel rails can now also be made with 5,000 pounds of coal, as compared with 10,000 pounds in 1868.

One of the most momentous and what may be called humanitarian results of the recent great extension and cheapening of the world's railway system and service is, that there is now no longer any occasion for the people of any country indulging in either excessive hopes or fears as to the results of any particular harvest; inasmuch as the failure of crops in any one country is no longer, as it was, no later than twenty years ago, identical with high prices of grain; the prices of cereals being at present regulated, not within any particular country, but by the combined production and comsumption of all countries made mutually accessible by railroads and steamships. Hence it is that, since 1870, years of locally bad crops in Europe have generally witnessed considerably lower prices than years when the local crops were good, and there was a local surplus for export.

In short, one marked effect of the present railroad and steamship system of transportation has been to compel a uniformity of prices for all commodities that are essential to life, and to put an end forever to what, less than half a century ago, was a constant feature of commerce, namely, the existence of local markets, with widely divergent prices for such commodities. How much of misery and starvation a locally deficient harvest entailed under the old system upon the poorer classes, through the absence of opportunity of supplying the deficiency

* The average price of iron rails in Great Britain for the year 1883 was £5 per ton. Steel rails in the same market sold in 1886 for £4.5 per ton; and the London "Economist" of June, 1887, mentions a sale of 4,500 tons of steel rails, by a Belgian company, at the equivalent of £3 16s ($18.47) per ton, deliverable at their works. Since the beginning of 1883 the manufacture of iron rails in the United States has been almost entirely discontinued, and during the years from 1883 to 1887 there were virtually no market quotations for them. The last recorded average price for iron rails was $45½ per ton in 1882. The yearly average price of steel rails at the works in Pennsylvania for 1886 was $28½.

through importations, is shown by the circumstance that in the English debates upon the corn laws, about the year 1840, it was estimated, upon data furnished by Mr. Tooke, in his "History of Prices," that a deficiency of one sixth in the English harvest resulted in a rise of at least 100 per cent in the price of grain; and another estimate by Davenant and King, for the close of the seventeenth century, corroborates this apparently excessive statement. The estimate of these latter authorities was as follows:

| For a deficit equal to— | There will be a rise in price of— |
|---|---|
| 1-10 | 3-10 |
| 2-10 | 8-10 |
| 3-10 | 16-10 |
| 4-10 | 28-10 |
| 5-10 | 45-10 |

As late as 1817, the difference in France between the highest and the lowest prices of grain in different parts of the country was 45 francs per hectolitre. In 1847 the average difference was 26 francs. Since 1870 the greatest difference at any time has not been in excess of 3·55 francs. The following table, given on German authority, and representing the price (in silver gulden per hectolitre) of grain for various periods, exhibits a like progress of price equalization between nations:

| PERIOD. | England. | France. | Belgium. | Prussia. |
|---|---|---|---|---|
| 1821–'30 | 10·25 | 7·35 | 6·44 | 5·65 |
| 1831–'40 | 9·60 | 7·61 | 7·31 | 5·27 |
| 1841–'50 | 9·15 | 7·89 | 7·99 | 6·41 |
| 1851–'60 | 9·40 | 7·84 | 9·65 | 8·07 |
| 1861–'70 | 8·80 | 8·59 | 9·24 | 7·79 |

For grain henceforth, therefore, the railroad and the steamship have decided that there shall be but one market—the world; and that the margin for speculation in this commodity, so essential to the well-being of humanity, shall be restricted to very narrow limits.

The world's total product of pig-iron increased slowly and regularly from 1870 to 1879, at the rate of about $2\frac{1}{2}$ per cent per annum; but after 1879 production increased enormously, "until in 1883 the advance among all nations reached 182·2 per cent on the make of 1870; that of the United Kingdom being 143·0, and of other countries 239·1 per cent." (*Testimony of Sir Lothian Bell, British Commission, 1886.*) Such an increase, justified perhaps at the moment, was far in excess of the ratio of increase in the world's population, and for a term of years greatly disproportionate to any increase in the world's consumption, and finally resulted, as has been before shown (see previous paper), in an extreme depression in the business, and a remarkable fall of prices. One experience from this condition of affairs in the United States is worthy of being placed on record: For a long time the effect of prevailing high prices for pig-iron, coupled with the influence of high protective duties imposed on the imports of foreign iron, was to maintain a large number of inferior furnaces in operation; but after 1882–'83 the most intelligent American iron-producers were compelled, as it were, to meet the stagnation and absence of profit in their business by effecting improvements in the quality of their furnaces, and undoubtedly also in their management; and with such effect that the average weekly capacity of the "anthracite" furnaces of the United States has been increased since 1883 from 220 to 264 tons, and of "bituminous" from 346 tons to 507, or to the extent of 46 per cent.

In the department of textile manufactures, investigation shows that, owing to the greater effectiveness of cotton-machinery, the manufacture of cotton-goods during recent years has also increased in a greater ratio than the increase of population; and that this increase has been going on at the rate of doubling the production in about twenty years. In the United States the doubling period of population is now about thirty-three years; in Europe, about seventy-five years; and, while in Oriental countries the doubling period is not definitely known, it is unquestionably longer than that of the United States. It would, therefore, seem certain that not only is the present product of manufactured cottons in excess of the world's present exchanging capacity, but also that, without a decrease in machinery product, the world's population must speedily increase their annual per capita consumption, if this state of things is not to continue. The report of the factory inspectors of the textile industries of Great Britain, for 1885, shows the following curious changes, consequent on improvements in machinery, to have taken place in the cotton-manufacture of Great Britain since 1874: A decrease of twenty in the whole number of cotton factories; a small increase in (throwing) spindles of 2,604,679, or 0·7 of 1 per cent (a result doubtless owing to the great improvement in the producing capacity of the spindle); an increase of 6·1 per cent in the number of persons employed; and an increase in the number of looms of 97,000, or 21 per cent. Taking all the textile industries of Great Britain into consideration, the number of hands employed in 1884, as compared with 1874, has not decreased, although the increase, 2·8 per cent, has been small in proportion to the increase in production. The number of children employed in 1884 was 34,000 less than 1874, while the number of male and female adults employed increased about 65,000; a change that implies an improvement in the social condition of the country, as well as an increased production.

The displacement of muscular labor in some of the cotton-mills of the United States, within the last ten years, by improved machinery has been from 33 to 50 per cent; and the average work of one operative working one year, in the best mills of the United States, will now, according to Mr. Atkinson, supply the annual wants of 1,600 fully clothed Chinese, or 3,000 partially clothed East Indians. In 1840 an operative in the cotton-mills of Rhode Island, working thirteen to fourteen hours a day, turned off 9,600 yards of standard sheeting in a year; in 1886 an operative in the same mill made about 30,000 yards, working ten hours a day. In 1840 the wages were $176 a year; in 1886 the wages were $285 a year.

The United States census returns for 1880, report a very large increase in the amount of coal and copper produced during the ten previous years in this country, with a very large comparative diminution in the number of hands employed in these two great mining industries; in anthracite coal the increase in the number of hands employed having been 33·2 per cent, as compared with an increase of product of 82·7; while in the case of copper the ratios were 15·8 and 70·8, respectively. For such results, the use of cheaper and more powerful blasting agents (dynamite), and of the steam-drill, furnish an explanation. And, in the way of further illustration, it may be stated that a car-load of coal, in the principal mining districts of the United States, can now (1887) be mined, hoisted, screened, cleaned, and loaded in one half the time that it required ten years previously.

The report of the United States Commissioner of Labor for 1886 furnishes the following additional illustrations:

"In the manufacture of agricultural implements, specific evidence is submitted, showing that six hundred men now do the work that, fifteen or twenty years ago, would have required 2,145 men, a displacement of 1,545.

"The manufacture of boots and shoes offers some very wonderful facts in this connection. In one large and long-established manufactory, the proprietors testify that it would require five hundred persons working by hand processes to make as many women's boots and shoes as a hundred persons now make with the aid of machinery; a displacement of eighty per cent."

"Another firm, engaged in the manufacture of children's shoes, states that the introduction of new machinery within the past thirty years has displaced about six times the amount of hand-labor required, and that the cost of the product has been reduced one half."

"On another grade of goods, the facts collected by the agents of the Bureau show that one man can now do the work which twenty years ago required ten men."

"In the manufacture of flour there has been a displacement of nearly three fourths of the manual labor necessary to produce the same product. In the manufacture of furniture, from one half to three fourths only of the old number of persons is now required. In the manufacture of wall-paper, the best evidence puts the displacement in the proportion of one hundred to one. In the manufacture of metals and metallic goods, long established firms testify that machinery has decreased manual labor 33⅓ per cent."

The following are other notable results, gathered from other sources, in what may be termed the minor industries:

In the manufacture of jewelry, one skilled workman, paid at the rate of two and a half to three dollars per day, and working according to anti-machine methods in use a few years ago, could make up three dozen pairs of sleeve-buttons per day. Now, one boy, paid five dollars per week, and working on the most modern machinery, can make up nine thousand pairs in a day. In gold (or imitation gold) chain-making, the United States now exports the cheapest grade of such jewelry produced by machinery to Germany, where cottage hand-labor, in the same avocation, can be had for a pittance, and finds a ready sale for them as against German manufacturers.

Nothing has had a greater influence in making possible the rapidity with which certain branches of retail business are now conducted, as compared with ten years ago—more especially the sale of groceries—than the cheap and rapid production of paper bags. At the outset, these bags were all made by hand-labor; but now machinery has crowded out the hand-workers, and factories are in existence in the United States which produce millions of paper bags per week, and not unfrequently fill single orders for three millions. With machinery have also come many improvements: square bags that stand up of themselves, and need only when filled from a measure to have the top edges turned over to make the package at once ready for delivery. A purchaser can now also take his butter or lard in paper trays that are brine and grease proof; his vinegar in paper jars that are warranted not to soak for one hour; a bottle of wine wrapped in a corrugated case that would not break if he dropped it on the pavement, and his oysters in paper pails that will hold water overnight. A few years ago, to have furnished gratuitously these packages, would have been deemed extravagance; but now it is found to pay as a matter of business.

The *sobriquet* of an apothecary was formerly that of a pill-maker; but the modern apothecary no longer makes pills, except upon special prescriptions; inasmuch as scores of large manufactories now produce pills by machinery according to the standard or other formulas, and every apothecary keeps and sells them, because they are cheaper, better, and more attractive than any that he can make himself.

Certain branches of occupation formerly of considerable importance seem to be passing out of existence under the influence of recent improvements. Previous to 1872, nearly all the calicoes of the world were dyed or printed with a coloring principle extracted from the root known as "*madder*"; the cultivation and preparation of which involved the use of thousands of acres of land in Holland, Belgium, Eastern France, Italy, and the Levant, and the employment of many hundreds of men, women, and children, and of large amounts of capital; the importation of madder into England for the year 1872 having been 28,731,600 pounds, and into the United States for the same year 7,786,000 pounds. To-day, two or three chemical establishments in Germany and England, employing but few men and a comparatively small capital, manufacture from coal-tar, at a greatly reduced price, the same coloring principle; and the former great business of growing and preparing madder—with the land, labor, and capital involved—is gradually becoming extinct; the importations into Great Britain for the year 1885 having declined to 2,472,000 pounds, and into the United States to 1,458,313 pounds.

The old-time art of making millstones—entitled to rank among the very first of labor-saving inventions at the very dawn of civilization—is rapidly passing into oblivion, because millstones are no longer necessary or economical for grinding the cereals. The steel roller produces more and better flour in the same time at less cost, and as an inevitable consequence is rapidly taking the place of the millstone in all countries that know how to use machinery. And, as the art of skillfully grooving the surface of a hard, flinty rock for its conversion into a millstone is so laborious, so difficult of accomplishment (four or five years of service being required in France from an apprentice before he is allowed to touch a valuable stone), and to a certain extent so dangerous from the flying particles of steel and stone, humanity, apart from all economic considerations, may well rejoice at its desuetude.

With the substitution of steamers for sailing-vessels upon the broad ocean, the former extensive business of sail-making, and the demand upon factories for heavy cloth as material for sails, experienced a notable depression, which in later years has continued and increased, because commerce along coast-lines also now no longer moves exclusively by sail, but largely in barges dragged or propelled by steam. For the four years next previous to 1886, the demand for sails in the United States is estimated to have decreased to the extent of about twenty-five per cent, although the carrying-trade of the country by ocean, coast, and inland waters, has, during the same time, increased very considerably.

Cotton-seed oil—an article a few years ago absolutely unknown in commerce, and prepared from what was formerly regarded almost in the light of a waste product, is now manufactured in the United States, and has come into such extensive use as a substitute for lard, olive, and other oils, for culinary and manufacturing purposes, that its present annual production and sale are estimated to be equivalent to about 70,000,000 pounds of lard; and has contributed not only to reduce notably the price and the place of that important hog-product in the world's markets, but also to impair the production and depress the price of almost all other vegetable oils—the product of the industries of other countries.

But in respect to no other one article has change in the conditions of production and distribution been productive of such momentous consequences as in the case of wheat. On the great wheat-fields of the Territory of Dakota, where machinery is applied to agriculture to such an extent that the requirement for manual labor has been reduced to a minimum, the annual product of one man's labor, working to the best advantage, is understood to be now equivalent to the production of 5,500 bushels of wheat. In the great mills of Minnesota, the labor of another one man for a year, under similar conditions as regards machinery, is in like manner equivalent to the conversion of this unit of 5,500 bushels of wheat into a thousand barrels of flour, leaving 500 bushels for seed-purposes; and although the conditions for analysis of the next step in the way of results are more difficult, it is reasonably certain that the year's labor of one and a half men more—or at the most two men—employed in railroad transportation, is equivalent to putting this thousand barrels of flour on a dock in New York ready for exportation; where the addition of a fraction of a cent a pound to the price will further transport and deliver it at almost any port of Europe.*

Here, then, we have the labor of three men for one year, working with machinery, resulting in producing all the flour that a thousand other men ordinarily eat in a year, allowing one barrel of flour for the average consumption of each adult. Before such a result the question of wages paid in the different branches of flour production and transportation becomes an insignificant factor in determining a market; and, accordingly, American flour grown in Dakota, and ground in Minneapolis, from a thousand to fifteen hundred miles from the nearest seaboard, by the labor of men paid from a dollar and a half to two dollars and a half per day for their labor, is sold in European markets at rates which are determinative of the prices which Russian peasants, Egyptian "fellahs," and Indian "ryots" can obtain in the same markets for similar grain grown by them on equally good soil, and with from fifteen to twenty cents per day wages for their labor.

A great number of other similar and equally remarkable experiences, derived from almost every department of industry except the handicrafts, might be presented; but it would seem that enough evidence has been offered to prove abundantly that, in the increased con-

* When the wheat reaches New York city, and comes into the possession of a great baker, who has established the manufacture of bread on a large scale, and who sells the best of bread to the working-people of New York at the lowest possible price, we find that one thousand barrels of flour can be converted into bread and sold over the counter by the work of three persons for one year. Let us add to the six and a half men already named the work of another man six months, or a half a man one year, to keep the machinery in repair, and our modern miracle is, that seven men suffice to give one thousand persons all the bread they customarily consume in one year. If to these we add three for the work of providing fuel and other materials to the railroad and the baker, our final result is that ten men working one year serve bread to one thousand."—*Distribution of Products*, EDWARD ATKINSON.

trol which mankind has acquired over the forces of Nature, and in the increased utilization of such control—mainly through machinery—for the work of production and distribution, is to be found a cause amply sufficient to account for the economic disturbance, which, since the year 1873, has been certainly universal in its influence over the domain of civilization, abnormal to the extent of justifying the claim of having been unprecedented in character, and which bids fair in a greater or less degree to continue indefinitely. Other causes may and doubtless have contributed to such a condition of affairs, but in this one cause alone (if the influences referred to can be properly considered as a unity) there has been sufficent of potentiality to account not only for all the economic phenomena that are under discussion, but to occasion a feeling of wonder that the world has accommodated itself so readily to the extent that it has to its new conditions, and that the disturbances have not been very much greater and more disastrous.

A question which these conclusions will naturally suggest may at once be anticipated. Have not these same influences, it may be asked, been exerted during the whole of the present century, and in fact ever since the inception of civilization; and are there any reasons for supposing that this influence has been different during recent years in kind and degree from what has been heretofore experienced? The answer is, Certainly in kind, but not in degree. The world has never seen anything comparable to the results of the recent system of transportation by land and water, never experienced in so short a time such an expansion of all that pertains to what is called business, and has never before, as was premised at the outset of this argument, been able to accomplish so much in the way of production with a given amount of labor in a given time. Thus it is claimed in respect to the German Empire, where the statistics of production and distribution have doubtless been more carefully studied by experts than elsewhere, that during the period from 1872 to 1885 there was an expansion in the railroad traffic of the empire of ninety per cent; in maritime tonnage, of about a hundred and twenty per cent; in the general mercantile or commercial movement, of sixty-seven per cent; in postal matter carried, of a hundred and eight per cent; in telegraphic dispatches, of sixty-one per cent; and in bank discounts, of two hundred and forty per cent. During the same period population increased about eleven and a half per cent; and from such data there has been a general deduction that, "if one unit of trade was the ratio to one unit of population in Germany in 1872, the proportion in 1885 was more than ten units of trade to one of population." But, be this as it may, it can not be doubted that whatever has been the industrial expansion of Germany in recent years, it has been at least equaled by England, approximated to by France, and certainly surpassed by the United States.

There is very much that contributes to the support of the idea which has been suggested by M. Laveleye, editor of the "Moniteur des Intérêts Matériels," at Brussels, that the industrial activity of the greater part of this century has been devoted to equipping fully the civilized countries of the world with economic tools, and that the work of the future, in this same sphere, must be necessarily that of repair and replacements rather than of new constructions. But a more important inference from this same idea, and one that fully harmonizes with and rationally explains the phenomena of the existing situation is, that the equipment having at last been made ready, the work of using it for production has in turn begun, and has been prosecuted so efficiently, that the world has within recent years, and for the first time, become saturated, as it were, under existing conditions for use and consumption, with the results of these modern improvements. Again, although the great natural labor-saving agencies had been recognized and brought into use many years prior to 1870, their powers were long kept, as it were, in abeyance; because it required time for the instrumentalities or methods by which the world's work of production and distribution was carried on to adjust themselves to new conditions; and until this was accomplished, an almost infinite number and variety of inventions which genius had produced for facilitating and accelerating industrial evolution were matters of promise, rather than of consummation. But with the extension of popular education and the rapid diffusion of intelligence, all new achievements in science and art have been brought in recent years so much more rapidly "within the sphere of the every-day activity of the people"—as the noted German inventor, Dr. Werner Siemens, has expressed it—"that stages of development, which ages ago required centuries for their consummation, and which at the beginning of our times required decades, now complete themselves in years, and not unfrequently present themselves at once in a state of completeness."

An influence which has been more potent in recent years than ever before in stimulating the invention and use of labor-saving machinery, and one which should not be overlooked in reasoning upon this subject, has been undoubtedly the increasing frequency of strikes and industrial revolts on the part of the large proportion of the population of all civilized countries engaged in the so-called mechanical occupations, which actions in turn on the part of such classes have been certainly largely prompted by the changes in the conditions of production resulting from prior labor-saving inventions and discoveries. As the London "Engineer" has already pointed out (see page 291, article No. 1), the remedy that at once suggests itself to every employer of labor on the occasion of such trouble with his employés is "to use a tool wherever it is possible instead of a man." A significant illustration of the quickness with with employers carry out this suggestion, is afforded by the well-authenticated fact that the strike among the boot and shoe factories of one county in the State of Massachusetts in the year 1885, resulted in the capacity for producing by the same factories during the succeeding year of a fully equal product, with reduction of at least fifteen hundred operatives; one machine improvement for effecting an operation called "lasting" having been introduced, which is capable of doing the former work of from two hundred to two hundred and fifty men with a force not exceeding fifty men.

Another fact confirmatory of the above conclusions, is that all investigators seem to be agreed that the depression of industry in recent years has been experienced with the greatest severity in those countries where machinery has been most largely adopted, and least, or almost not at all, in those countries and in those occupations where hand-labor and hand-labor products have not been materially interfered with or supplanted. There is no evidence that the mass of the people of any country removed from the great lines of the world's commerce, as in China, India, Turkey, Mexico, and the states of Northern Africa, have experienced any economic disturbance prior to 1883, except from variations in crops, or civil commotions; and if the experience of a few of such countries has been different since 1883, the causes may undoubtedly be referred to the final influence of long-delayed extraneous disturbances, as has been the case in Mexico, in respect to the universal depreciation of silver,* and in Japan, from an apparent culmination of a long series of changes in the civilization and economy of that country. There have, moreover, been no displacements of labor or reduction in the cost of labor or product in all those industries in civilized countries, where machinery has not been increased; as, for example, in domestic service, in such departments of agriculture as the raising and care of stock, the growing of cotton, of flax, hemp, and of tropical fibers of like character, or in such mechanical occupations as masonry, painting, upholstering, plastering, and cigar-making, or those of engineers, firemen, teamsters, watchmen, and the like.

Finally, it is of the first importance to note how all the other causes which have been popularly regarded as having directly occasioned, or essentially contributed to, the recent depression of trade and industry —with the exception of such as are in the nature of natural phenomena, as bad seasons and harvests, diseases of plants and animals, disappearance of fish, and the like, and such as are due to excessive taxation, consequent on war expenditures, all of which are local, and the first temporary in character—naturally group themselves about the one great cause that has been suggested, as sequences or derivatives, and as secondary rather than primary in their influence; and to the facts and deductions that are confirmatory of this conclusion attention will be next invited.

* The average rate of exchange in Mexico on London fell from 41 to 46 per dollar in the early months of 1885 to 38 to 76 in the spring of 1886.

# NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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## III.—METEOROLOGY (*concluded*).

WHILE the Fathers and school-men were laboring to deduce a science of meteorology from our sacred books, there oozed up in European society a mass of traditions and observances which had been lurking since the days of paganism ; and, although here and there appeared a churchman to oppose them, the theologians and ecclesiastics ere long began to adopt them and to clothe them with the authority of religion.

Both among the pagans of the Roman Empire and among the barbarians of the North the Christian missionaries had found it easier to prove the new God supreme than to prove the old gods powerless. Faith in the miracles of the new religion seemed to increase rather than to diminish faith in the miracles of the old ; and the Church at last began admitting the latter as facts, but ascribing them to the devil. Jupiter and Odin sank into the category of ministers of Satan, and transferred to that master all their former powers. A renewed study of Scripture by the theologians, in the light of this hypothesis, elicited overwhelming proofs of its truth. They found very many sacred texts to support it, and it soon became a dogma. So strong was the hold it took, under the influence of the Church, that not until late in the seventeenth century did its substantial truth begin to be questioned.

Now, with no field of action had the sway of the ancient deities been more identified than with that of atmospheric phenomena. The Roman heard Jupiter, and the Teuton heard Thor, in the thunder. Could it be doubted that these powerful beings would now take occasion, unless hindered by the command of the Almighty, to vent their spite against those who had deserted their altars? Might not the Almighty himself be willing to employ the malice of these powers of the air against those who had offended him?

It was, indeed, no great step, for those whose simple faith accepted rain or sunshine as an answer to their prayers, to suspect that the untimely storms or droughts, which baffled their most earnest petitions, were the work of the arch-enemy, "the prince of the power of the air."

The great Fathers of the Church had laid the basis of this doctrine in Scripture. Saint Jerome declared the air to be full of devils, basing this belief upon various statements in the prophecies of Isaiah and in the Epistle to the Ephesians.* Saint Augustine held the same view as beyond controversy.†

During the middle ages this doctrine of the diabolical origin of storms went on gathering strength. Bede had full faith in it, and narrates various anecdotes in support of it.‡ Saint Thomas Aquinas gave it his sanction, saying in his all-authoritative "Summa": "Rains and winds, and whatsoever occurs by local impulse alone, can be caused by demons." "It is," he says, "a dogma of faith that the demons can produce wind, storms, and rain of fire from heaven." #

Albert the Great taught the same doctrine, and showed how a certain salve thrown into a spring produced whirlwinds.‖ The great Franciscan—the "seraphic doctor"—Saint Bonaventura, whose services to theology earned him one of the highest places in the Church, and to whom Dante gave special honor in paradise, set upon this belief his high authority.△ The lives of the saints, and the chronicles of the middle ages, were filled with it. Poetry and painting accepted the idea and developed it. Dante wedded it to verse,◊ and at Venice this thought may still be seen embodied in one of the grand pictures of Bordone: a ship-load of demons is seen approaching Venice in a storm, threatening destruction to the city, but Saint Mark, Saint George, and Saint Nicholas attack the vessel, and disperse the hellish crew.‡

The popes again and again sanctioned this doctrine, and it was amalgamated with various local superstitions, pious imaginations, and interesting arguments, to strike the fancy of the people at large. A strong argument in favor of a diabolical origin of the thunderbolt was afforded by the eccentricities of its operation. These attracted especial attention in the middle ages, and the popular love of marvel generalized isolated phenomena into rules. Thus, it was said that the lightning strikes the sword in the sheath, gold in the purse, the foot in the shoe, leaving sheath, and purse, and shoe unharmed; that it consumes a human being internally without injuring the skin; that it destroys

* Thus, in his "Com. in Epist. ad Ephesios" (iii, 6), commenting on the text, "Our battle is not with flesh and blood," he explains this as meaning the devils in the air; and adds: "Nam et in alio loco de dæmonibus quod in aere isto vagentur, Apostolus ait: In quibus ambulastis aliquando juxta sæculum mundi istius, secundum principem potestatis aeris spiritus, qui nunc operatur in filios diffidentiæ" (Ephes. ii, 2). "Hæc autem omnium doctorum opinio est, quod aer iste qui cœlum et terram medius dividens, inane appellatur, plenus sit contrariis fortitudinibus." See also his "Com. in Isaiam," xiii, 50 (Migne, "Patr. Lat.," xxiv, 477).

† As to Augustine, see the "De Civitate Dei," *passim*.

‡ See Bede, "Hist. Eccles.," i, 17; "Vita Cuthberti," c. 17.

\# See Thomas Aquinas, "Summa," pars I, qu. lxxx, art. 2, cited by Maury, "Légendes Pieuses," 11. The second citation I owe to Rydberg, "Magic of the Middle Ages," 73, where the whole interesting passage is given at length.

‖ See Albertus Magnus, "De Potentia Dæmonum" (cited by Maury, as above).

△ See Bonaventura, "Comp. Theol. Veritat.," ii, 26.

◊ See Dante, "Purgatorio," c. 5.

‡ See Maury, "Légendes Pieuses," 18, note.

nets in the water, but not on the land; that it kills one man, and leaves untouched another standing beside him; that it can tear through a house and enter the earth without moving a stone from its place; that it injures the heart of a tree, but not the bark; that wine is poisoned by it, while poisons struck by it lose their venom; that a man's hair may be consumed by it, and the man be unhurt.*

These peculiar phenomena, made much of by the allegorizing sermonizers of the day, were used in moral lessons from every pulpit. Thus, the Carmelite, Matthias Farinator, of Vienna, who at the pope's own instance compiled early in the fifteenth century that curious handbook of illustrative examples for preachers, the "Lumen Animæ," finds a spiritual analogue for each of these anomalies.†

This doctrine grew robust and noxious, until, in the fifteenth, sixteenth, and seventeenth centuries, we find its bloom in a multitude of treatises by the most learned of the Catholic and Protestant divines, and its fruitage in the torture-chambers and on the scaffolds throughout Christendom. At the Reformation period, and for nearly two hundred years afterward, Catholics and Protestants vied with each other in promoting this growth. John Eck, the great opponent of Luther, gave to the world an annotated edition of Aristotle's "Physics," which was long authoritative in the German universities; and, though the text is free from this doctrine, the woodcut illustrating the earth's atmosphere shows most vividly, among the clouds of mid-air, the devils who there reign supreme.‡

Luther, in the other religious camp, supported the superstition even more zealously, asserting at times his belief that the winds themselves are only good or evil spirits,# and declaring that he had himself calmed more than twenty storms caused by the devil.‖

Just at the close of the same century, Catholics and Protestants hailed alike the great work of Delrio.△ In this the power of devils over the elements is proved first from the Holy Scriptures, since, he declares, "they show that Satan brought fire down from heaven to consume the servants and flocks of Job, and that he stirred up a violent wind, which overwhelmed in ruin the sons and daughters of Job at their feasting"; next, Delrio insists on the agreement of all the orthodox Fathers that it was the devil himself who did this, and attention is called to the fact that the hail with which the Egyptians were punished is expressly declared in Holy Scripture to have been brought

* See, for lists of such *admiranda*, any of the early writers—e. g., Vincent of Beauvais, Reisch's "Margarita," or Eck's "Aristotle."

† See the "Lumen Animæ," Eichstadt, 1479.

‡ See Eck, "Aristotelis Meteorologica," Augsburg, 1519.

\# See his "Memoirs," iii, 172 (cited by Maury, "Légendes Pieuses," 18).

‖ See his "Memoirs," p. 190 (cited by Maury, as above, p. 18).

△ His "Disquisitiones Magicæ," first printed at Liége in 1599–1600 (in three vols. 4to), but reprinted again and again throughout the seventeenth century.

by the evil angels.* Citing from the Apocalypse, he points to the four angels standing at the fourcorners of the earth, holding back the winds and preventing their doing great damage to mortals ;† and he dwells especially upon the fact that the devil is called by the apostle a "prince of the power of the air."‡ He then goes on to cite the great Fathers of the Church, Clement, Jerome, Augustine, and Thomas Aquinas.#

This doctrine was spread, not only in ponderous treatises, but in light literature, and by popular illustrations. In the "Compendium Maleficarum" of the Italian monk Guacci, perhaps the most amusing book in the whole literature of witchcraft, we may see the witch, *in propria persona*, riding the diabolic goat through the clouds while the storm rages around and beneath her ; and we may read a rich collection of anecdotes, largely contemporary, which establish the required doctrine beyond question.‖

The first and most natural means taken against this work of Satan in the air, was Prayer ; and various petitions are to be found scattered through the Christian liturgies—some very beautiful and touching. This means of escape has been relied upon, with greater or less faith, from those days to these. Various mediæval saints and reformers, and devoted men in all centuries, from Saint Giles to John Wesley, have used it with results claimed to be miraculous.^ Whatever theory any thinking man may hold in the matter, he will certainly not venture a reproachful word : such prayers have been in all ages a natural outcome of the mind of man in trouble.

But against the "powers of the air" were used other means of a very different character and tendency, and foremost among these was Exorcism. In an exorcism widely used and ascribed to Pope Gregory XIII, the formula is given : "I, a priest of Christ, . . . do command ye, most foul spirits, who do stir up these clouds, . . . that ye depart from them, and disperse yourselves into wild and untilled places, that ye may be no longer able to harm men or animals or fruits or herbs or whatsoever is designed for human use." But this is mild, indeed, compared to some later exorcisms, as when the ritual runs: "All the people shall rise, and the priest, turning toward the clouds, shall pronounce these words : 'I exorcise ye, accursed demons, who have dared to use, for the accomplishment of your iniquity, those powers of Nature

* This interpretation of Psalm lxxviii, 47–49, was apparently shared by the translators of our own authorized version.

† Revelation, vii, 1.

‡ Ephesians, ii, 2. Even according to modern commentators (e. g. Alford) the word here translated "power" denotes, not *might*, but *government*, *court*, *heirarchy* ; and in this sense it was always used by the ecclesiastical writers, whose conception is best rendered by our plural—"powers."

\# See Delrio, "Disquisitiones Magicæ," lib. ii, c. 11.

‖ See Guacci, "Compendium Maleficarum" (Milan, 1606).

^ For the cases of Saint Giles, John Wesley, and others stilling the tempests, see Brewer, "Dictionary of Miracles," s. v. "Prayer."

by which God in divers ways worketh good to mortals; who stir up winds, gather vapors, form clouds, and condense them into hail. . . . I exorcise ye, . . . that ye relinquish the work ye have begun, dissolve the hail, scatter the clouds, disperse the vapors, and restrain the winds.'" The rubric goes on to order that then there shall be a great fire kindled in an open place, and that over it the sign of the cross shall be made, and the one hundred and fourteenth Psalm chanted, while malodorous substances, among them sulphur and asafœtida, shall be cast into the flames. The purpose seems to have been literally to "smoke out" Satan.*

Manuals of exorcisms became important—some bulky quartos, others hand-books. Noteworthy among the latter is one by the Italian priest Locatelli, entitled "Exorcisms most Powerful and Efficacious for the Dispelling of Aërial Tempests, whether raised by Demons at their own Instance or at the Beck of some Servant of the Devil." †

The Jesuit Gretser, in his famous book on "Benedictions and Maledictions," devotes a chapter to this subject, dismisses summarily the skepticism that questions the power of devils over the elements, and adduces the story of Job as conclusive.‡

Nor was this theory of exorcism by any means confined to the elder Church. Luther vehemently upheld it, and prescribed especially the first chapter of St. John's gospel as of unfailing efficacy against thunder and lightning, declaring that he had often found the mere sign of the cross, with the text, "The word was made flesh," sufficient to put storms to flight.#

From the beginning of the middle ages until long after the Reformation, the chronicles give ample illustration of the successful use of such exorcisms. So strong was the belief in them that it forced itself into minds comparatively rational, and found utterance in treatises of much importance.

But, since exorcisms were found at times ineffectual, other means were sought, and especially Fetiches of various sorts. One of the earliest of these appeared when Pope Alexander I, in the second century, ordained that holy-water should be kept in churches and bedchambers to drive away devils.‖ Another safeguard was found in relics, and

* See Polidorus Valerius, "Practica exorcistarum"; also the "Thesaurus exorcismorum" (Cologne, 1626), 158–162.

† That is, "Exorcismi," etc. A "corrected" second edition was printed at Laybach, 1680, in 24mo, to which is appended another manual of "Preces et conjurationes contra aëreas tempestates, omnibus sacerdotibus utiles et necessaria," printed at the monastery of Kempten (in Bavaria) in 1667. The latter bears as epigraph the passage from the gospels describing Christ's stilling of the winds.

‡ See Gretser, "De benedictionibus et maledictionibus," lib. ii, c. 48.

\# See Gretser, as above.

‖ "Instituit ut aqua quam sanctam appellamus sale admixta interpositis sacris orationibus et in templis et in cubiculis ad fugandos dæmones retineretur."—Platina, "Vitæ Pontif.," s. v. Alexander (108–117 A. D.).

of similar efficacy were the so-called "conception billets" sold by the Carmelite monks. They contained a formula upon consecrated paper, at which the devil might well turn pale. Buried in the corner of a field, one of these was thought to give protection against bad weather and destructive insects.*

But highest in repute during centuries was the *Agnus Dei*—a piece of wax blessed by the pope's own hand, and stamped with the well-known device representing the "Lamb of God." † Its powers were so marvelous that Pope Urban V thought three of them a fitting gift from himself to the Greek emperor. In the Latin doggerel recounting their virtues, their meteorological efficacy stands first, for especial stress is laid on their power of dispelling the thunder. This stress thus laid by Pope Urban, as the infallible guide of Christendom, on the efficacy of this fetich, gave it great value throughout Europe, and the doggerel verses reciting its virtues sank deep into the popular mind.‡ It was considered a most potent means of dispelling hail, pestilence, storms, conflagrations, and enchantments; and this feeling was deepened by the rules and rites for its consecration.# So solemn was the matter, that the manufacture and sale of this particular fetich was, by a papal bull of 1471, reserved for the pope himself,‖ and he only performed the required ceremony in the first and seventh years of his pontificate. Standing unmitred, he prayed: "O God, . . . we humbly beseech thee that thou wilt bless these waxen forms, figured with the image of an innocent lamb, . . . that, at the touch and sight of them, the faithful may break forth into praises, and that the crash of hailstorms, the blast of hurricanes, the violence of tempests, the fury of winds, and the malice of thunderbolts may be tempered, and evil spirits flee and tremble before the standard of thy holy cross, which is graven upon them." ^

* See Rydberg, "The Magic of the Middle Ages," translated by Edgren, pp. 64–66.

† They are still in use in the Church, and may be found described in any ecclesiastical cyclopædia.

‡ "Tonitrua magna terret,
Et peccata nostra delet;
Ab incendio præservat,
A submersione servat,
A morte cita liberat,
Et Cacodæmones fugat,
Inimicos nostros domat,
Prægnantem cum partu salvat,
Dona dignis multa confert,
Utque malis mala defert.
Portio, quamvis parva sit,
Ut magna tamen proficit."

See these verses cited in full faith, so late as 1743, in Father Vincent of Berg's "Enchiridium," pp. 23, 24, where is a full account of the virtues of the *Agnus Dei*, and instructions for its use.

\# A full account of these rites, with the consecrating prayers and benedictions which gave color to this theory of the powers of the *Agnus Dei*, may be found in the ritual of the Church. I have used the edition entitled "Sacrarum ceremoniarum sive rituum Sanctæ Romanæ Ecclesiæ libri tres," Rome, 1560, in folio.

‖ See Rydberg, "Magic of the Middle Ages," p. 63.

^ "Deus, . . . te suppliciter deprecamur, ut . . . has cereas formas, innocentissimi agni imagine figuratas, benedicere . . . digneris, ut per ejus tactum et visum fideles in-

Another favorite means with the clergy of the older Church, for bringing to naught the powers of the air, was found in great Processions, bearing statues, relics, and holy emblems through the streets.* Yet, even these were not always immediately effective. One at Liége, in the thirteenth century, thrice proved unsuccessful in bringing rain, when at last it was found that the image of the Virgin had been forgotten! A new procession was at once formed, the *Salve Regina* sung, and the rain came down in such torrents as to drive the devotees to shelter.†

In Catholic lands this custom remains to this day, and very important features in these processions are the statues and reliquaries of patron saints. Some of these excel in bringing sunshine, others in bringing rain. The Cathedral of Chartres is so fortunate as to possess sundry relics of Saint Taurin, especially potent against dry weather, and some of Saint Piat, very nearly as infallible against wet weather.‡ In certain regions a single saint gives protection alternately against wet and dry weather—as, for example, Saint Godeberte at Noyon.# Against storms Saint Barbara is very generally considered the most powerful protectress; but, in the French diocese of Limoges, Notre Dame de Crocq has proved a most powerful rival, for when, a few years since, all the neighboring parishes were ravaged by storms, not a hailstone fell in the canton which she protected. In the diocese of Tarbes, Saint Exupère is especially invoked against hail, peasants flocking from all the surrounding country to his shrine.‖

But the means of baffling the powers of the air which came to be most widely used was the ringing of consecrated Church-Bells.

This usage had begun in the time of Charlemagne, and there is extant a prohibition of his against the custom of baptizing bells and of hanging certain tags ^ on their tongues as a protection against hailstorms; but even Charlemagne was powerless against this current of mediæval superstition. Theological reasons were soon poured into it, and, about the year 970, Pope John XIII is said to have baptized a bell in the Lateran, christening it with his own name, to have stood sponsor

vitentur ad laudes, fragor grandinum, procella turbinum, impetus tempestatum, ventorum rabies, infesta tonitrua temperentur, fugiant atque tremiscant maligni spiritus ante Sanctæ Crucis vexillum, quod in illis exsculptum est. . . ." ("Sacr. Cer. Rom. Eccl.," as above.) If any are curious as to the extent to which this consecrated wax was a specific for all spiritual and most temporal ills during the sixteenth and seventeenth centuries, let them consult the Jesuit "Litteræ annuæ," *passim*.

* John of Winterthur describes many such in Switzerland in the thirteenth century, and all the monkish chronicles speak of them.

† See Rydberg, "Magic of the Middle Ages," p. 74.

‡ See the "Guide du touriste et du pèlerin à Chartres," 1867 (cited by "Paul Parfait," in his "Dossier des Pèlerinages").

\# See "Paul Parfait," as above, p. 139.

‖ See "Paul Parfait," as above, p. 145.

^ "Perticæ." See Montanus, "Hist. Nachricht von den Glocken" (Chemnitz, 1726), p. 121; and Meyer, "Der Aberglaube des Mittelalters," p. 186.

for one of the bells of St. Peter's, and to have issued a bull for the baptizing of bells "to cleanse the air of devils." *

This idea was rapidly developed, and we soon find it supported in ponderous treatises, spread widely in sermons, and popularized in multitudes of inscriptions cast upon the bells themselves. This branch of theological literature may still be studied in multitudes of church-towers throughout Europe. A bell at Basel bears the inscription, "Ad fugandos demones." Another, in Lugano, declares "The sound of this bell vanquishes tempests, repels demons, and summons men." Another, at the Cathedral of Erfurt, declares that it can "ward off lightning and malignant demons." † A peal in the Jesuit church at the university town of Pont-à-Mousson bore the words, "They praise God, put to flight the clouds, affright the demons, and call the people." This is dated 1634. Another bell in that part of France declares, "It is I who dissipate the thunders" (*Ego sum qui dissipo tonitrua*).‡

Another, in one of the forest cantons of Switzerland, bears a doggerel couplet, which may be thus translated:

> "On the devil my spite I'll vent,
> And, God helping, bad weather prevent." #

Very common were inscriptions embodying this doctrine in sonorous Latin.

In accordance with this doctrine, there grew up a ritual for the consecration of bells. Knollys, in his translation of the quaint old chronicler Sleidan, gives us the usage in the simple English of the middle of the sixteenth century:

"In lyke sorte [as churches] are the belles used. And first, forsouth, they must hange so, as the Byshop may goe round about them. Whiche after he hath sayde certen Psalmes, he consecrateth water and salte, and mingleth them together, wherwith he washeth the belle diligently both within and without, after wypeth it drie, and with holy oyle draweth in it the signe of the crosse, and prayeth God, that whan they shall rynge or sounde that bell, all the disceiptes of the devyll may vanyshe away, hayle, thondryng, lightening, wyndes, and tempestes, and all untemperate weathers may be aswaged. Whan he hath wipte out the crosse of oyle wyth a linen cloth, he maketh seven other crosses in the same, and within one only. After saying certen Psalmes, he taketh a payre of sensours and senseth the bel within, and

* Such is the current statement (see, e. g., Higgins's "Anacalypsis," ii, 70), but I am unable to find satisfactory record of this bull. Platina relates only ("Vitæ Pontif." s. v. John XIII) that this pope stood sponsor for a bell of St. Peter's.

† These illustrations, with others equally striking, may be found in Meyer, "Der Aberglaube des Mittelalters," 185, 186.

‡ For these two instances and many more, see Germain, "Anciennes cloches lorraines" (Nancy, 1885), pp. 23, 27.

\# "An dem Tüfel will ich mich rächen,
Mit der hilf gotz alle bösen wetter zerbrechen."
(See Meyer, as above.)

prayeth God to sende it good lucke. In many places they make a great dyner, and kepe a feast as it were at a solemne wedding." *

These bell baptisms became matters of great importance. Popes, kings, and prelates were proud to stand as sponsors. During the French Revolution, four of the bells at the Cathedral of Versailles were destroyed; and on the 6th of January, 1824, four new ones were baptized, the Voltairian, King Louis XVIII, and the pious Duchess d'Angoulême standing as sponsors.

In some of these ceremonies, zeal appears to have outrun knowledge, and one of Luther's stories, at the expense of the older Church, was that certain authorities thus christened a bell "Hosanna," supposing that to be the name of a woman.

To add to the efficacy of such baptisms, water was sometimes brought from the river Jordan.†

The prayers used at bell baptisms fully recognize this doctrine; the ritual of Paris embraces the petition that "whensoever this bell shall sound, it shall drive away the malign influences of the assailing spirits, the horror of their apparitions, the rush of whirlwinds, the stroke of lightning, the harm of thunder, the disasters of storms, and all the spirits of the tempest." ‡ Another prayer begs that "the sound of this bell may put to flight the fiery darts of the enemy of men"; # and others vary the form but not the substance of this petition. The great Jesuit theologian, Bellarmin, did indeed try to deny the reality of this baptism; but this can only be regarded as a piece of casuistry suited to Protestant hardness of heart, or as strategy in the warfare against heretics.

Forms of baptism were laid down in various manuals sanctioned directly by papal authority, and sacramental efficacy was everywhere taken for granted.‖ The development of this idea in the older Church was too strong to be resisted; ^ but, as a rule, the Protestant theolo-

* Sleidan's "Commentaries," English translation, as above, fol. 334 (lib. xxi, sub anno 1549).

† See Montanus, as above, who cites Beck, "Lutherthum vor Luthero," p. 294, for the statement that many bells were carried to the Jordan by pilgrims for this purpose.

‡ See Arago, "Œuvres" (Paris, 1854), vol. iv, p. 322.

\# Arago, as above.

‖ As has often been pointed out, the ceremony was in all its details—even to the sponsors, the wrapping a garment about the baptized, the baptismal fee, the feast—precisely the same as when a child was baptized. Magius, who is no skeptic, relates, from his own experience, an instance of this sort, where a certain bishop stood sponsor for two bells, giving them both his own name—William (see his "De Tintinnabulis," xiv).

^ And no wonder, when the oracle of the Church, Thomas Aquinas, expressly pronounced church-bells, "provided they have been duly consecrated and baptized," the foremost means of "frustrating the atmospheric mischiefs of the devil," and likened steeples in which bells are ringing to a hen brooding her chickens, "for the tones of the consecrated metal repel the demons and avert storm and lightning"; when pre-Reformation preachers of such universal currency as Joannes Herolt could declare, "Bells, as all agree, are baptized with the result that they are secure from the power of Satan, gians of the Reformation, while admitting that storms were caused by Satan and his legions, opposed the baptism of bells, and denied the theory of their influence in dispersing storms.* Luther, while never doubting that troublesome meteorological phenomena were caused by devils, regarded with contempt the idea that the demons were so childish as to be scared by the clang of bells; his theory of diabolic power made them altogether too powerful to be affected by means so trivial. The great English reformers, while also accepting very generally the theory of diabolic interference in storms, reproved strongly the baptizing of bells, as the perversion of a sacrament, and involving blasphemy. Bishop Hooper declared reliance upon bells to drive away tempests, futile; † Bishop Pilkington, while arguing that tempests are direct instruments of God's wrath, is very severe against using "unlawful means," and among these he names "the hallowed bell"; ‡ and these opinions were very generally shared by the leading English clergy. #

Toward the end of the sixteenth century the Elector of Saxony strictly forbade the ringing of bells against storms, urging penance and prayer instead; ‖ but the custom was not so easily driven out of the Protestant Church, and in some quarters was developed a Protestant theory of a rationalistic sort—ascribing the good effects of bell-ringing in storms to the calling together of the devout for prayer or to the suggestion of prayers during storms at night.^ As late as the end of the seventeenth century we find the bells of Protestant churches in Northern Germany rung for the dispelling of tempests.◊ In Catholic Austria this bell-ringing seems to have become a nuisance in the last century, for the Emperor Joseph II found it necessary to issue an edict against it; but this doctrine had gained too large headway to be arrested by argument or edict, and the bells may be heard ringing during storms to this day in various remote districts in Europe.

For this was no mere superficial view. It was really part of a deep

terrify the demons, compel the powers"; and when a canonist like Durandus explained the purpose of the rite to be, that "the demons hearing the trumpets of the Eternal King, to wit, the bells, may flee in terror, and may cease from the stirring up of tempests." (See Herolt, "Sermones Discipuli," xvii, and Durandus, "De ritibus ecclesiæ," ii, 12.) (I owe the first of these citations to Rydberg, and the others to Montanus.)

* The baptism of bells was, indeed, one of the express complaints of the German Protestant princes at the Reformation. See their "Gravam. Cent. German. Grav.," 51.

† See his "Early Writings," 197 (in "Parker Society Publications").

‡ See his "Works," 177 (in "Parker Society Publications").

\# E. g., by Tyndale, Bishop Ridley, Archbishop Sandys, Becon, Calfhill, Rogers. It is to be noted that all these speak of the rite as "baptism."

‖ See Peuchen, "Disp. circa tempestates," Jena, 1697.

^ See, e. g., the "Conciones Selectæ" of Superintendent Conrad Dieterich (cited by Peuchen, "Disp. circa tempestates").

◊ See Schwimmer, "Physicalische Luftfragen," 1692 (cited by Peuchen, as above). He pictures the whole population of a Thuringian district flocking to the churches on the approach of a storm.

theological current steadily developed through the middle ages, the fundamental idea of the whole being the evident influence of the bells upon the "power of the air"; and it is perhaps worth our while to go back a little and glance over the growth of this deeper current in modern times. Having grown steadily through the middle ages, it appeared in full strength at the Reformation period; and in the sixteenth century Olaus Magnus, Archbishop of Upsala and Primate of Sweden, in his great work on the northern nations, declares it a well-established fact that cities and harvests may be saved from lightning by the ringing of bells and the burning of consecrated incense, accompanied by prayers; and he cautions his readers that the workings of the thunderbolt are rather to be marveled at than inquired into.* Even as late as 1673 the Franciscan professor Lealus, in Italy, in a school-book which was received with great applause in his region, taught unhesitatingly the agency of demons in storms, and the power of bells over them, as well as the portentousness of comets and the movement of the heavens by angels. He dwells especially, too, upon the perfect protection afforded by the waxen *Agnus Dei*. How strong this current was, and how difficult even for philosophical minds to oppose, is shown by the fact that both Descartes † and Francis Bacon speak of it with respect, Bacon admitting the fact, and suggesting very mildly that the bells may accomplish this purpose by the concussion of the air.‡

But no such moderate doctrine sufficed, and the renowned Bishop Binsfeld, of Treves, in his great treatise on the credibility of the confessions of witches, gave an entire chapter to the effect of bells in calming atmospheric disturbances. Basing his general doctrine upon the first chapter of Job and the second chapter of Ephesians, he insisted on the reality of diabolic agency in storms; and then, by theological reasoning, corroborated by the statements extorted in the torture-chamber, he showed the efficacy of bells in putting the hellish legions to flight.# This continued, therefore, an accepted tenet, developed in every nation, and coming to its climax near the end of the seventeenth century. At that period—the period of Isaac Newton—Father Augustine de Angelis, rector of the Clementine College at Rome, published under the highest church authority his lectures upon meteorology. Coming from the center of Catholic Christendom, at so late a period, they are very important as indicating what had been developed under the influence of theology during nearly seventeen hundred years. This learned head of a great college at the heart of Christendom taught that "the surest remedy against thunder is that

* See Olaus Magnus, "De gentibus septentrionalibus" (Rome, 1555), lib. i, c. 12, 13.

† See his "Sylva Sylvarum," cent. ii, p. 103 (cited by Montanus, as above).

‡ See his "Natural History," ii, cent. 2, 127. In his "Historia Ventorum" he again alludes to the belief, and without comment.

\# See Binsfeld, "De Confessionibus Malef." (pp. 308-314, of edition of 1623).

which our Holy Mother the Church practices, namely, the ringing of bells when a thunderbolt impends: thence follows a twofold effect, physical and moral—a physical, because the sound variously disturbs and agitates the air, and by agitation disperses the hot exhalations and dispels the thunder; but the moral effect is the more certain, because by the sound the faithful are stirred to pour forth their prayers, by which they win from God the turning away of the thunderbolt." * Here we see in this branch of thought, as in so many others, at the close of the seventeenth century, the dawn of rationalism. Father De Angelis now keeps demoniacal influence in the background. Little, indeed, is said of the efficiency of bells in putting to flight the legions of Satan: the wise professor is evidently preparing for that inevitable compromise which we see in the history of every science when it is clear that it can no longer be suppressed by ecclesiastical fulminations.

But, while this apparently harmless doctrine regarding modes of dealing with the powers of the air was developed, there were evolved another theory and a series of practices sanctioned by the Church, which must forever be considered as among the fearful calamities in human history. Indeed, few errors have ever cost so much shedding of innocent blood over such wide territory and during so many generations. Out of the old doctrine—pagan and Christian—of evil agency in atmospheric phenomena, was evolved the belief that certain men, women, and children had secured infernal aid to produce whirlwinds, frosts, floods, and the like.

As early as the ninth century one great churchman, Agobard, Archbishop of Lyons, struck a heavy blow at this superstition. His work, "Against the Absurd Opinion of the Vulgar touching Hail and Thunder," shows him to have been one of the most devoted apostles of right reason whom human history has known. By argument and ridicule, and at times by a lofty eloquence, he attempted to breast this tide. One passage is of historical significance. He declares: "The wretched world lies now under the tyranny of foolishness; things are believed by Christians of such absurdity as no one ever could aforetime induce the heathen to believe." †

All in vain; the tide of superstition continued to roll on; great theologians developed it and ecclesiastics favored it; until as we near the end of the mediæval period the infallible voice of Rome is heard accepting it, and clinching this belief into the mind of Christianity. For, in 1437, Pope Eugene IV, by virtue of the teaching power conferred on him by the Almighty, and under the divine guarantee

* See De Angelis, "Lectiones Meteorol.," 75.

† For a very interesting statement of Agobard's position and work, with citations from his "Liber contra insulsam vulgi opinionem de grandine et tonitruis," see Poole, "Illustrations of the History of Mediæval Thought," 40, *et seq.* The works of Agobard may be found in vol. civ of Migne's "Patrol. Lat."

against any possible error, issued a bull exhorting the inquisitors of heresy and witchcraft to use greater diligence against the human agents of the Prince of Darkness, and especially against those who have the power to produce bad weather. In 1445 Pope Eugene returned again to the charge, and again issued instructions and commands infallibly committing the Church to the doctrine.* But a greater than Eugene followed and stamped the idea yet more deeply into the mind of the Church. On the 7th of December, 1484, Pope Innocent VIII sent forth his bull "*Summis Desiderantes.*" Of all documents ever issued from Rome, imperial or papal, this has doubtless, first and last, cost the greatest shedding of innocent blood. Yet no document was ever more clearly dictated by conscience. Inspired by the scriptural command, "Thou shalt not suffer a witch to live," Pope Innocent exhorted the clergy of Germany to leave no means untried to detect sorcerers, and especially those who by evil weather destroy vineyards, gardens, meadows, and growing crops.† These precepts were based upon various texts of Scripture, especially upon the famous statement in the book of Job; and, to carry them out, witch-finding inquisitors were authorized by the Pope to scour Europe, especially Germany, and a manual was prepared for their use, the "Witch-Hammer," *Malleus Maleficarum*. In this manual, which was revered for centuries, both in Catholic and Protestant countries, as almost divinely inspired, the doctrine of Satanic agency in atmospheric phenomena was further developed, and various means of detecting and punishing it were dwelt upon.‡

With the application of torture to thousands of women, in accordance with the precepts laid down in this work, it was not difficult to extract masses of proof for this "sacred theory" of meteorology. The poor creatures, writhing on the rack, held in horror by those who had been nearest and dearest to them, anxious only for death to relieve their sufferings, confessed to anything and everything that would satisfy the inquisitors and judges. All that was needed was that the inquisitors should ask leading questions # and suggest satisfactory answers: the prisoners, to shorten the torture, were sure sooner or later to give the answer required, even though they knew that this would

* See Raynaldus, "Annales Eccl.," 1437, 1445.

† The Latin text of the bull may be found in the *Malleus* about to be described, in Binsfeld's "De Confessionibus," cited below, or in Roskoff's "Geschichte des Teufels" (Leipsic, 1869), i, 222–225.

‡ There is, so far as I know, no good analysis, in any English book, of the contents of the "Witch-Hammer"; but such may be found in Roskoff's "Geschichte des Teufels," or in Soldan's "Geschichte der Hexenprozesse." Its first dated edition is that of 1489. It was, happily, never translated into any modern tongue.

# For still extant lists of such questions, see the "Zeitschrift für deutschen Culturgeschichte" for 1858, pp. 522–528, or Diefenbach, "Der Hexenwahn in Deutschland," pp. 15–17. Father Vincent of Berg (in his "Enchiridium") gives a similar list for use by priests in the confession of the accused.

send them to the stake or scaffold. Under the doctrine of "excepted cases," there was no limit to torture for persons accused of heresy or witchcraft; even the safeguards which the old pagan world had imposed upon torture were thus thrown down, and the prisoner *must* confess.

The theological literature of the middle ages was thus enriched with numberless statements regarding modes of Satanic influence on the weather. Pathetic, indeed, are the records; and none more so than the confessions of these poor creatures, chiefly women and children, during hundreds of years, as to their manner of raising hailstorms and tempests. Such confessions, by tens of thousands, are still to be found in the judicial records of Germany, and indeed of all Europe. Typical among these "facts" thus revealed is one on which great stress was laid during ages, and for which the world was first indebted to one of these poor women. Crazed by the agony of torture, she declared that, returning with a demon through the air from the witches' sabbath, she was dropped upon the earth in the confusion which resulted among the hellish legions when they heard the bells sounding the *Ave Maria*. It is sad to note that, after a confession so valuable to sacred science, the poor woman was condemned to the flames. This revelation speedily ripened the belief that, whatever might be going on at the witches' sabbath—no matter how triumphant Satan might be—at the moment of sounding the consecrated bells the Satanic power was paralyzed. This theory once started, proofs came in to support it, during a hundred years, from the torture-chambers in all parts of Europe. Throughout the later middle ages the Dominicans had been the main agents in extorting and promulgating these revelations, but in the centuries following the Reformation the Jesuits devoted themselves with even more keenness and vigor to the same task.* Some curious questions incidentally arose. It was mooted among the orthodox authorities whether the damage done by storms should or should not be assessed upon the property of convicted witches: the theologians inclined decidedly to the affirmative; the jurists, on the whole, to the negative.

But, in spite of these tortures, lightning and tempests continued, and great men arose in the Church throughout Europe in every generation to point out new cruelties for the discovery of "weather-makers," and new methods for bringing their machinations to naught. Here and there, indeed, a thinker endeavored to modify or oppose this view. Early in the sixteenth century Paracelsus called attention to the reverberation of cannon as explaining the rolling of thunder,† but he was confronted by one of the greatest men of his time. Jean Bodin, as superstitious in natural as he was rational in political science, made

* For proofs of this, see not only the histories of witchcraft, but also the "Annuæ litteræ" of the Jesuits themselves, *passim*.

† See the citation from him in Fromond's "Meteorologica," lib. iii, c. 9.

sport of this scientific theory, and declared thunder to be "a flaming exhalation set in motion by evil spirits, and hurled downward with a great crash and a horrible smell of sulphur." * In support of this view, he dwells upon the confessions of tortured witches, upon the acknowledged agency of demons in the will-o'-the wisp, and specially upon the passage in the 104th Psalm, "Who maketh his angels spirits, his ministers a flaming fire." † To resist such powerful arguments by such powerful men was dangerous indeed. In 1513, Pomponatius, professor at Padua, published a volume of "Doubts as to the Fourth Book of Aristotle's Meteorologica," ‡ and also dared to question this power of devils; but he soon found it advisable to explain that, while as a *philosopher* he might doubt, yet as a *Christian* he of course believed everything taught by Mother Church—devils and all—and so escaped the fate of several others who dared to question the agency of witches in atmospheric and other disturbances. Before the end of the sixteenth century, Cornelius Loos, professor in the University of Treves, daring to express similar doubts, was seized by the Inquisition, forced to recant, and banished. Just a century later the Protestant divine, Balthasar Bekker, in Holland, who ventured not only to question the devil's power over the weather, but to deny his bodily existence altogether, was solemnly tried by the synod of his church, and expelled from his pulpit, while his views were condemned as heresy, and overwhelmed with a flood of refutations whose mere catalogue would fill pages; and these cases were but typical of many.

The great upholders of the orthodox view retained full possession of the field. Famous among these was Bishop Binsfeld, of Treves, who, toward the end of the sixteenth century, wrote a book to prove that everything confessed by the witches under torture, especially the raising of storms and the general controlling of the weather, was worthy of belief; and this book became throughout Europe a standard authority, both among Catholics and Protestants.# Even more inflexible was Remigius, criminal judge in Lorraine. On the title-page of his manual ‖ he boasts that within fifteen years he had sent nine hundred persons to death for this imaginary crime.

Protestantism fell into the superstition as fully as Catholicism. In

* He adds: "Id certissimam dæmonis præsentiam significat: nam ubicunque dæmones cum hominibus nefaria societatis fide copulantur, fœdissimum semper relinquunt sulphuris odorem, quod sortilegi sæpissime experiuntur et confitentur."

† See Bodin's "Universæ Naturæ Theatrum" (Frankfort, 1597), pp. 208–211.

‡ The first edition of this book, which was the earliest of Pomponatius's writings, is excessively rare; but it was reprinted at Venice just a half-century later. It is in his *De incantationibus*, however, that he speaks especially of devils. As to Pomponatius, see Creighton's "History of the Papacy during the Reformation," and an excellent essay in Franck's "Moralistes et Philosophes."

# It bore the title of "Tractatus de confessionibus maleficorum et sagarum." First published at Treves in 1589, it appeared subsequently four times in the original Latin, as well as in two distinct German translations, and in a French one.

‖ "Dæmonolatreia," first printed at Lyons in 1595.

Germany, during the century following the Reformation, the great Saxon jurist, Benedict Carpzov, distinguished himself by his skill in demonstrating the reality of the crime from Scripture, and by his cruelty in detecting and punishing it by torture.

Typical as to the attitude of Scotch and English Protestants, was the theory and practice of King James I, "the crowned Solomon," himself the author of a book on demonology. James had married the Princess of Denmark, and the ship which bore her to the British shores encountered tempests. Skillful use of unlimited torture soon brought the causes to light. A Doctor Fian, while his legs were crushed in the "boots" and wedges driven under his finger-nails, confessed that several hundred witches had gone to sea in a sieve from the port of Leith, and had raised storms and tempests to drive back the king's bride.* Still later, in the second half of the seventeenth century, we see a typical example of the same superstition in England in the case of Meric Casaubon, Doctor of Divinity and an ecclesiastic in high position at Canterbury. He declared fully for the doctrine that witches raise storms, citing the foremost ecclesiastical authorities.†

In America, the great weight of the elder Mather was thrown on the same side.‡ But, in spite of all these great authorities, in every land, and in spite of such summary punishments as those of Loos and Bekker, scientific thought was developed; and, at the end of the seventeenth century, this vast growth of superstition began to wither and droop. Bayle in France, Calef in New England, and Thomasius in Germany, did much to create an intellectual and moral atmosphere fatal to it. Torture being abolished, "weather-makers" no longer confessed; and the fundamental proofs in which the system was rooted were evidently slipping away. Even the great theologian

* The best accounts of James's share in the extortion of these confessions may be found in the collection of "Curious Tracts" published at Edinburgh in 1820. (See also King James's own "Demonologie," and Pitcairn's "Criminal Trials of Scotland," vol. i, part ii, pp. 213–223.)

† See his "Credulity and Incredulity in Things Natural," pp. 66, 67.

‡ Thus, in his sermons (already cited) on "The Voice of God in Stormy Winds" (Boston, 1704), he says: "When there are great Tempests, the Angels oftentimes have an hand therein. . . . Yea, and sometimes, by Divine Permission, Evil Angels have a Hand in such Storms and Tempests as are very hurtful to Men on the Earth." Yet, "for the most part, such Storms are sent by the Providence of God as a Sign of His Displeasure for the Sins of Men," and sometimes "as Prognosticks and terrible Warnings of Great Judgments not far off." And thus from the height of his erudition he rebukes the timid voice of scientific skepticism: "There are some who would be esteemed the Wits of the World, that ridicule those as Superstitious and Weak Persons, which look upon Dreadful Tempests as Prodromous [*sic*] of other Judgments. Nevertheless, the most Learned and Judicious Writers, not only of the Gentiles, but amongst Christians, have Embraced such a Persuasion; their Sentiments therein being Confirmed by the Experience of many Ages." For another curious turn given to this theory, with reference to sanitary science, see Deodat Lawson's famous sermon at Salem, in 1692, on "Christ's Fidelity a Shield against Satan's Malignity" (p. 21 of the second edition).

Fromundus, at the University of Louvain, the oracle of his age, who had demonstrated the futility of the Copernican theory, now tends toward the inevitable attempt at compromise, and declares that devils, though *often*, are not *always*, or even "for the most part," the causes of thunder.* And the learned Jesuit, Caspar Schott, whose "Physica Curiosa" was one of the most popular books of the seventeenth century, ventures only the same mild statement.† But even such a concession by so great champions of orthodoxy did not prevent frantic efforts in various quarters to bring the world back under the old dogma, and, as late as 1743, we find a manual by Father Vincent of Berg,‡ in which the superstition is taught to its fullest extent, issued for the use of priests, under the express sanction of the theological professors of the University of Cologne.

It was hardly out of press, when there came a death-blow to the whole theory. In 1752 Franklin made his experiments with the kite on the banks of the Schuylkill; and, at the moment when he drew the electric spark from the cloud, the whole tremendous fabric of theological meteorology reared by the Fathers, the Popes, the mediæval Doctors, and the long line of great theologians, Catholic and Protestant, collapsed; the "Prince of the power of the air" tumbled from his seat; the great doctrine which had so long afflicted the earth was prostrated forever.

The experiment of Franklin was repeated in various parts of Europe, but, at first, the Church seemed careful to take no notice of it. The old church formulas against the powers of the air were still used, but the theological theory, especially in the Protestant Church, began to grow milder. Four years after Franklin's discovery Pastor Karl Koken, member of the Consistory and official preacher to the City Council of Hildesheim, was moved by a great hailstorm to preach and publish a sermon on "The Revelation of God in Weather." # Of "the prince of the power of the air" he says nothing—the whole theory of diabolical agency is thrown overboard altogether; his whole attempt is to save the older and more harmless theory, that the storm is the voice of God. He insists that, since Christ told Nicodemus that men "know not whence the wind cometh," it can not be of mere natural origin, but is sent directly by God himself, as David intimates in the Psalm, "out of His secret places." As to the hailstorm, he lays great stress upon the plague of hail sent by the Almighty upon Egypt, and

* See Fromundus's "Meteorologica" (London, 1656) lib. iii, c. 9, and lib. ii, c. 3.

† See Schott's "Physica Curiosa" (edition of Würzburg, 1667), p. 1249.

‡ His "Enchiridium quadripartitum" (Cologne, 1743). Besides benedictions and exorcisms for all emergencies, it contains full directions for the manufacture of the *Agnus Dei*, and of another sacred panacea called "Heiligthum," not less effective against evil powers, gives formulæ to be worn for protection against the devil, suggests a list of signs by which diabolical possession may be infallibly recognized, and prescribes the questions to be asked by priests in the examination of witches.

\# "Die Offenbarung Gottes in Wetter" (Hildesheim, 1756).

clinches all by insisting that God showed at Mount Sinai his purpose to startle the body before impressing the conscience.

While the theory of diabolical agency in storms was thus drooping and dying, very shrewd efforts were made at compromise, such as we always see in the history of every science when its victory is fully in sight. The first of these attempts we have already noted in the effort to explain the efficacy of bells in storms by their simple use in stirring the faithful to prayer, and in the concession made by sundry theologians, and even by the great Lord Bacon himself, that church-bells might, under the sanction of Providence, disperse storms by agitating the air. This gained ground somewhat, though it was resisted by one eminent church authority, who answered shrewdly that, in that case, cannon would be even more pious instruments.* Still another argument used in trying to save this part of the theological theory was that the bells were consecrated instruments for this purpose, "like the horns at whose blowing the walls of Jericho fell."

But these compromises were of little avail. In 1766 Father Sterzinger attacked the very groundwork of the whole diabolic theory. He was, of course, bitterly assailed, insulted, and hated; but the Church thought it best not to condemn him. More and more, the "Prince of the power of the air" retreated before the lightning-rod of Franklin. The older Church, while clinging to the old theory theoretically, was finally obliged to confess the supremacy of Franklin's theory practically; for his lightning-rod did what exorcisms, and holy water, and processions, and the *Agnus Dei*, and the ringing of church-bells, and the rack, and the burning of witches, had failed to do. This was clearly seen, even by the poorest peasants in Eastern France, when they observed that the grand spire of Strasburg Cathedral, which neither the sacredness of the place, nor the bells within it, nor the holy water and relics beneath it, could protect from frequent injuries by lightning, was once and for all protected by Franklin's rod. Then came into the minds of multitudes the answer to the question which had exercised for ages the leading theological minds of Europe, namely, "Why should the Almighty strike his own consecrated temples, or suffer Satan to strike them?"

Yet even this practical solution of the great question was not received without opposition. The first lightning-conductor upon a church in England was not put up until 1762, ten years after Franklin's discovery. The spire of Saint Bride's Church in London was greatly injured by lightning in 1750, and in 1764 a storm so wrecked its masonry that it had to be mainly rebuilt; yet for years after this the authorities refused to attach a lightning-rod!† The Protestant Cathedral of Saint Paul's in London was not protected until sixteen years after Franklin's discovery, and the tower of the great Protestant church at Hamburg

* See Gretser's "De Benedictionibus," lib. ii, c. 46.

† See Priestley, "History of Electricity," p. 407.

not until a year later still. As late as 1783 it was declared in Germany, on excellent authority, that within a space of thirty-three years nearly four hundred towers had been damaged, and one hundred and twenty bell-ringers killed.

In Roman Catholic countries a similar prejudice was shown, and its cost at times was heavy. In Austria the church of Rosenberg, in the mountains of Carinthia, was struck so frequently, and with such loss of life, that the peasants feared at last to attend service. Three times was the spire rebuilt, and it was not until 1778—twenty-six years after Franklin's discovery—that the authorities permitted a rod to be attached. Then all trouble ceased.

Typical in Italy was the tower of Saint Mark's at Venice. In spite of the angel at its summit and the bells consecrated to ward off the powers of the air, and the relics in the cathedral hard by, and the processions in the adjacent piazza, the tower was frequently injured and even ruined by lightning. In 1388 it was badly shattered; in 1417, and again in 1489, the wooden spire surmounting it was utterly consumed; it was again greatly injured in 1548, 1565, 1653, and in 1745 was struck so powerfully that the whole tower, which had been rebuilt of stone and brick, was shattered in thirty-seven places. Although the invention of Franklin had been introduced into Italy by the physicist Beccaria, the tower of Saint Mark's still went unprotected, and was again badly struck in 1761 and 1762; and not until 1766—fourteen years after Franklin's discovery—was a lightning-rod placed upon it: and it has never been struck since.

So, too, though the beautiful tower of the Cathedral of Siena, protected by all possible theological means, had been struck again and again, much opposition was shown to placing upon it what was generally known as "the heretical rod"; but the tower was at last protected by Franklin's invention, and in 1777, though a very heavy bolt passed down the rod, the church received not the slightest injury. This served to reconcile theology and science, so far as that city was concerned; but the case which did most to convert the Italian theologians to the scientific view was that of the church of Saint-Nazaire at Brescia. The Republic of Venice had stored in the vaults of this church over two hundred thousand pounds of powder. In 1767—seventeen years after Franklin's discovery—no rod having been placed upon it, it was struck by lightning, the powder in the vaults was exploded, one sixth of the entire city destroyed, and over three thousand lives lost.*

Such examples as these, in all parts of Europe, had their effect. The formulas for conjuring off storms, and for consecrating bells to ward off lightning and tempests, and for putting to flight the powers of the air, were still allowed to stand in the liturgies; but the lightning-rod, the barometer, and the thermometer, carried the day.

* See article on "Lightning" in the "Edinburgh Review" for October, 1844.

A noble line of investigators succeeding Franklin completed his victory. The traveler in remote districts of Europe still hears the church-bells ringing during tempests; the Polish or Italian peasant is still persuaded to pay fees for sounding bells to keep off hailstorms; but the universal tendency favors more and more the use of the lightning-rod, and of the insurance-offices where men can be relieved of the ruinous results of meteorological disturbances in accordance with the scientific laws of average, based upon the ascertained recurrence of storms. So, too, though many a poor seaman trusts to his charm that has been bathed in holy water, or that has touched some relic, the tendency among mariners is to value more and more those warnings which are sent far and wide each day over the earth and under the sea by the electric wires in accordance with laws ascertained by observation.

Yet, even in our own time, attempts to revive the old theological doctrine of meteorology have not been wanting. Two of these, one in a Roman Catholic and another in a Protestant country, will serve as types of many, to show how completely scientific truth has saturated and permeated minds supposed to be entirely surrendered to the theological view.

The Island of Saint Honorat, just off the southern coast of France, is deservedly one of the places most venerated in Christendom. The monastery of Lérins, founded there in the fourth century, became a mother of similar institutions in Western Europe, and a center of religious teaching for the Christian world. In its atmosphere, legends and myths grew in beauty and luxuriance. Here, as the chroniclers tell us, at the touch of Saint Honorat, burst forth a stream of living water, which a recent historian of the monastery declares a greater miracle than that of Moses; here he destroyed, with a touch of his staff, the reptiles which infested the island, and then forced the sea to wash away their foul remains. Here, to please his sister, Sainte-Marguerite, a cherry-tree burst into full bloom every month; here he threw his cloak upon the waters and it became a raft, which bore him safely to visit the neighboring island; here, Saint Patrick received from Saint Just the staff with which he imitated Saint Honorat by driving all reptiles from Ireland.

Pillaged by Saracens and pirates, the island was made all the more precious by the blood of Christian martyrs. Popes and kings made pilgrimages to it; saints, confessors, and bishops went forth from it into all Europe; in one of its cells, Saint Vincent of Lérins wrote that famous definition of pure religion* which, for nearly fifteen hundred years, has virtually superseded that of Saint James. Naturally, the monastery became most illustrious, and its seat "the Mediterranean Isle of Saints."

* That "religion is that which is received always, everywhere, and by all" (*semper, ubique, ab omnibus*).

But, toward the close of the last century, its inmates having become slothful and corrupt, it was dismantled, all save a small portion torn down, and the island became the property, first of impiety, embodied in a French actress, and finally of heresy, embodied in an English clergyman.

Bought back for the Church by the Bishop of Fréjus in 1869, there was little revival of life for twelve years. Then came the reaction, religious and political, after the humiliation of France and the Vatican by Germany ; and of this reaction the monastery of Saint Honorat was made one of the most striking outward and visible signs. Pius IX interested himself directly in it, called into it a body of Cistercian monks, and it became the chief seat of their order in France. To restore its sacredness the strict system of La Trappe was established—labor, silence, meditation on death. The word thus given from Rome was seconded in France by cardinals, archbishops, and all churchmen especially anxious for promotion in this world or salvation in the next. Worn-out dukes and duchesses of the Faubourg Saint-Germain united in this enterprise of pious reaction with the frivolous youngsters, the *petits crevés,* who haunt the purlieus of Notre Dame de Lorette. The great church of the monastery was handsomely rebuilt and a multitude of altars erected ; and beautiful frescoes and stained windows came from the leaders of the recation. The whole effect was, perhaps, somewhat too theatrical and thin, but it showed none the less earnestness in making the old "Isle of Saints" a protest against the hated modern world.

As if to bid defiance still further to modern liberalism, great store of relics was sent in—among these, pieces of the true cross, of the white and purple robes, of the crown of thorns, sponge, lance, and winding-sheet of Christ—the hair, robe, veil, and girdle of the Blessed Virgin—relics of Saint John the Baptist, Saint Joseph, Saint Mary Magdalene, Saint Paul, Saint Barnabas, the four Evangelists, and a multitude of other saints ; so many that the bare mention of these treasures requires twenty-four distinct heads in the official catalogue recently published at the monastery. Besides all this—what was considered even more powerful in warding off harm from the revived monastery—the bodies of Christian martyrs were brought from the Roman catacombs and laid beneath the altars.*

All was thus conformed to the mediæval view ; nothing was to be left which could remind one of the nineteenth century ; the "ages of faith" were to be restored in their simplicity. Pope Leo XIII commended to the brethren the writings of Saint Thomas Aquinas, as their one great object of study ; and works published at the monastery dwelt upon the miracles of Saint Honorat as the most precious refutation of modern science.

* See the "Guide des Visiteurs à Lérins," published at the monastery in 1880, p. 204 ; also the "Histoire de Lérins," mentioned below.

High in the cupola, above the altars and relics, were placed the bells. Sent by pious donors, they were solemnly baptized and consecrated in 1871, four bishops officiating, a multitude of the faithful being present from all parts of Europe, and the sponsors of the great tenor bell being the Bourbon claimant to the ducal throne of Parma and his duchess. The good bishop who baptized the bells consecrated them with a formula announcing their efficacy in driving away the "prince of the power of the air," and the lightning and tempests he provokes.

And then, above all, at the summit of the central spire, high above relics, altars, and bells, was placed—*a lightning-rod!* *

The account of the monastery, published under the direction of the present worthy abbot, more than hints at the saving, by its bells, of a ship which was wrecked a few years since on that coast; and yet, to protect the bells and church and monks and relics from the very foe whom, in the mediæval faith, all these were thought most powerful to drive away, recourse was had to the scientific discovery of that "arch-infidel," Benjamin Franklin!

Perhaps the most striking recent example in Protestant lands of this change from the old to the new, occurred not long since in one of the great Pacific dependencies of the British crown. At a time of severe drought, an appeal was made to the bishop, Dr. Moorhouse, to order public prayers for rain. The bishop refused, advising the petitioners for the future to take better care of their water-supply, virtually telling them, "Heaven helps those who help themselves." But most noteworthy in this matter was it that the English Government, not long after, scanning the horizon to find some man to take up the good work laid down by the lamented Bishop Fraser, of Manchester, chose Dr. Moorhouse; and his utterance upon meteorology, which a few generations since would have been regarded by the whole Church as blasphemy, was universally alluded to as an example of strong good sense, proving him especially fit for one of the most important bishoprics in England.

Throughout Christendom, the prevalence of the conviction that meteorology is obedient to laws, is more and more evident. In cities especially, where men are accustomed each day to see posted in public places charts which show the storms moving over various parts of the country, and to read in the morning papers scientific prophecies as to the weather, the old view can hardly be very influential.

* See "Guide," as above, p. 84. "Les Isles de Lérins," by the Abbé Alliez (Paris, 1860), and the "Histoire de Lérins," by the same author, are the authorities for the general history of the abbey, and are especially strong in presenting the miracles of Saint Honorat, etc. The "Cartulaire" of the monastery, recently published, is also valuable. But these do not cover the recent revival, for an account of which recourse must be had to the very interesting and *naïve* "Guide" already cited.

Significant of this was the feeling of the American people during the fearful droughts a few years since in the States west of the Missouri. No days were appointed for fasting and prayer to bring rain—there was no attribution of the calamity to the wrath of God or the malice of Satan; but much was said regarding the folly of our people in allowing the upper regions of their vast rivers to be denuded of forests, thus subjecting the States below to alternations of drought and deluge. Partly as a result of this, a beginning has been made of teaching forest-culture in many schools, tree-planting societies have been formed, and "Arbor-day" is recognized in several of the States. A true and noble theology can hardly fail to recognize in the love of Nature and care for our fellow-men thus promoted, something far better, both from a religious and a moral point of view, than any efforts to propitiate the Divine anger by flattery, or to avert Satanic malice by fetichism.

## THE FALLS OF THE MISSISSIPPI.

By JOHN ARNOLD KEYES.

THE Mississippi River and its tributaries, forming as they do one of the most important river systems on the globe, and draining one of the most richly-furnished continental areas, present, moreover, many interesting geological studies, and open up fields of curious inquiry to the investigator. The old discussions as to the possibility or impossibility of things has, for the most part, passed out of existence in this department of science. No one now denies the general principles of geology as at present taught; therefore new regions of investigation are to be approached on the firm foundation of the old, and difficult matters settled in conformity with established principles. That there is no new thing under the sun is a saying well worn, but in one sense correct, yet the same thing recognized as a fact in one situation may under other circumstances seem a fallacy. The Falls of Niagara are familiar to all, and came to exist through causes natural and easy of explanation, inasmuch as the whole secret lies in the character of the formations over which the river flows, viz., a crust made up of from sixty to one hundred feet of comparatively hard limestone lying in a nearly horizontal position, beneath which is a deep deposit of shales and sandstones. Whenever the river in wearing its channel back reached the point where this arrangement of rocks began, the hard limestone would naturally resist the erosive action of the waters, while the underlying shales and sandstones, offering less resistance, would be rapidly cut away, until a vertical fall such as is now seen would be the result, with a constant recession going on, leaving below the broad cañon, walled on either hand by bluffs, the crests of which are preserved by the limestone crowning them.

These few reflections as to the falls and gorge of Niagara, fully demonstrated by forces now in active operation, we shall apply to the Mississippi. Here also a mighty water-way has been cut out by erosion, a fact which is universally conceded, but no definite explanation of the process has heretofore, so far as we have been able to learn, been advanced. It remained for a geology-reading inventor by the name of Robert Bates to suggest a theory which, illuminated with what little investigation we have been able to give it, promises to offer a solution of the question, or to assist in its solution. The theory briefly is, that the erosion was accomplished by means of a mighty cataract which began far down the river near its original mouth, and by gradual retrocession dug out the valley-like gorge which is so marked a feature in the upper part of its course, and left the high bluff walls on either hand, at the same time depositing heavy beds of sand at the bottom of the cañon, the product of the erosion above, and that St. Anthony Falls are the ever decreasing and receding remnants of the once most stupendous cataract the world ever saw, having a perpendicular descent of perhaps six hundred feet.

Stretching over almost the entire Mississippi Valley immediately overlying the Azoic rocks lie the old and extensive beds of the Potsdam sandstone, a formation of great thickness composed of shales and friable sandstones.

From the Wisconsin River to the Falls of St. Anthony the formations through which the Mississippi has cut its way are—first, the St. Lawrence, or, as Owen has termed it, lower magnesian limestone, very analogous to the Niagara formation in density and durability.

This stratum is from one hundred and fifty to two hundred and twenty-five feet in thickness, and lies in a nearly horizontal position, dipping somewhat to the west, but not to any great extent between the Wisconsin River and St. Anthony Falls. Second, underlying this and forming a part of the Potsdam group is the St. Croix sandstone, with perhaps other sand-rock and shales local in extent. A section of the bluff in Houston County, Minnesota, gives the St. Lawrence crowning it a thickness of nearly two hundred feet, with three hundred and twenty feet of sand-rock and shale beneath.

Another measurement of a bluff in the town of Richmond, Winona County, indicates a little over one hundred and ten feet of limestone overlying four hundred feet of St. Croix sandstone. Other measurements have been made in different localities, but without doubt these already given indicate the general positions and relative thickness of the different strata. The conditions, it will here be observed, are similar to those existing at Niagara, viz., a hard limestone superimposing a soft sandstone and shale deposit.

These bluff walls rise on either hand to a height of from three hundred to five hundred and fifty feet above the water-level of the river, and have been laterally furrowed and eroded by streams flowing from the adjacent country, and in a much greater degree by glacial action, as it is a well-established fact that the river had cut its way (except for a short distance below St. Anthony) prior to the glacial epoch. On account of this lateral furrowing the bluff walls present a broken and serrated appearance, but this, when rightly considered, does not in the least militate against the correctness of the cataract theory. The valley gorge, which is from two to six miles, is at present somewhat wider at the top where the cliffs appear, and where wind and frost have been free to act, than the water originally cut it, and the *débris* falling below has formed a talus which, increased and modified by glacial action, has to a considerable extent effaced the wall-like appearance which is such a marked feature of the comparatively freshly-cut cañon of Niagara.

Another fact which has hitherto received no satisfactory explanation is the deep accumulation of sand in the valley-bottom. There are no data sufficient to determine the depth of this deposit, but as the great river nowhere flows upon a rock-bed, but everywhere, except in its extreme northern section, has a sand bottom; and, as cities and villages are built within the bluffs on the compact accumulations at the sides of the present channel, we conclude that it must have a depth of several hundred feet.

If the gorge had been chiseled out by a process of gradual wear (which would have been the case if the strata had been of uniform resisting power), then the river should flow upon a rock-bed, and not upon sand, for the latter would, as it now does, protect the underlying strata from all wear. Upon the cataract hypothesis this peculiar condition can be met with an easy and satisfactory explanation. The descent of the Mississippi is very gradual. Directly at the base of the falls, wherever they may have originated, the sand-rock would be cut down to a depth determined by the comparative hardness of the rocks and the volume of water. For a short distance below the descent the rock would be swept clean of sand and *débris*, except, perhaps, the large limestone chunks fallen from above, but as the stream came to flow more evenly below the falls, sand from the erosion above would be deposited at the bottom. Two other existing conditions would assist in the deposit: first, the very slight fall of the river; and, second, the detached masses of limestone broken from the crest of the falls would help to collect and retain the sediment, and thus the accumulation would begin. All these facts, taken in connection with the further fact that no bluffs appear above St. Anthony Falls, while they are continuous below, except where broken by the lateral erosion, have a tendency to establish the theory advanced. Just how far to the south the requisite conditions of stratification exist, we have not as yet ascertained, but they probably exist wherever the limestone-capped bluffs bound the river. If the limestone formation is wanting at any place, there rapids would have taken the place of falls, and so continued until the limestone again appeared in its natural position.

There are no rock-bluffs below the confluence of the Ohio with the Mississippi, but about thirty miles above that point they abruptly rise on both sides of the river at what is called the Grand Chain, a high rock ridge traversing the region from east to west, and which lies at a considerable height above the sea-level. There, in all probability, the river had its original outlet, and there, without doubt, the cataract process began, although the character of the stratification is unknown to us. At the time the erosion was in progress, there must have been several times the present volume of water flowing in the river, spreading out wider than the bluff, even, as an occasional terrace shows. The same perpendicular rock-walls and sand-bottom characterize the Wisconsin River for a distance of eighty miles from its junction with the Mississippi ; the position and character of the stratification being much the same, indicating that the same agency was active in the erosion of both channels.

St. Anthony Falls have been studied by Professor Winchell, and he has arrived at the conclusion from various data that the falls have worked their way back from a point near Fort Snelling to where they now are, a distance of about eight miles, since the glacial period, and he estimates that it has taken about five thousand years to accomplish the work, which estimate, taken as a basis of calculation, and allowing a margin of at least one third, gives us the time necessary to cut out the entire channel at, say, four hundred thousand years ; and this, if, as we maintain, the cataract process wrought the gorge not only from Fort Snelling northward, but from far down the river, at or near the ancient outlet, is without doubt a conservative estimate of the time actually required.

We have thus briefly outlined the new theory of the Mississippi erosion, and this is written with the expectation that the barbed arrows of scientific criticism will be aimed toward it ; but, if so, it will aid in the solution of a question hitherto little studied. Many things point toward the theory here advanced as being at least quite possible, and even probable. Its final solution will, however, necessitate painstaking investigation, with the attention directed to that especial object.

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Madame Clémence Royer, writing in the "Revue d'Anthropologie," does not doubt that, under a proper system of training, apes might be made good workers. They lack perseverance, indeed, but in general intelligence they are superior to most other domestic animals. They would, however, have to be fed great quantities of fruit, bread, and eggs ; the process of educating them would be costly ; and for many generations they would be injuriously affected by northern climates. Madame Royer suggests that, if the experiment be made, it be first in tropical climates, where apes might be taught to labor in connection with the cultivation of coffee, cocoa, and cotton.

# ASTRONOMY WITH AN OPERA-GLASS.

## THE MOON AND THE SUN.

By GARRETT P. SERVISS.

"IT is a most beautiful and delightful sight," exclaims Galileo, in describing the discoveries he had made with his telescope, "to behold the body of the moon, which is distant from us nearly sixty semi-diameters of the earth, as near as if it was at a distance of only two of the same measures. . . . And, consequently, any one may know with the certainty that is due to the use of our senses that the moon assuredly does not possess a smooth and polished surface, but one rough and uneven, and, just like the face of the earth itself, is everywhere full of vast protuberances, deep chasms, and sinuosities."

There was, perhaps, nothing in the long series of discoveries with which Galileo astonished the world after he had constructed his telescope, which, as he expresses it, "was devised by me through God's grace first enlightening my mind," that had a greater charm for him than his lunar observations. Certainly there was nothing which he has described with greater enthusiasm and eloquence. And this could hardly have been otherwise, for the moon was the first celestial object to which Galileo turned his telescope, and then for the first time human eyes may be said to have actually looked into another world than the earth, though his discoveries and those of his successors have not realized all the poetic fancies about the moon contained in the verses that are ascribed to Orpheus :

> "And he another wandering world has made
> Which gods Selene name, and men the moon.
> It mountains, cities has, and temples grand."

Yet Galileo's observations at once upset the theory, for which Apollonius was responsible, and which seems to have been widely prevalent up to his time, that the moon was a smooth body, polished like a mirror, and presenting in its light and dark spots reflections of the continents and oceans of the earth. He also demonstrated that its surface was covered with plains and mountains, but the "cities and temples" of the moon have remained to our time only within the ken of romance.

Galileo's telescope, as I have before remarked, was, in the principle of its construction, simply an opera-glass of one tube. He succeeded in making a glass of this kind that magnified thirty diameters, a very much higher power than is given to the opera- and field-glasses of to-day. Yet he had to contend with the disadvantages of single lenses, achromatic combinations of glass for optical purposes not being contrived until nearly a hundred years after his death, and so his telescope did not possess quite as decided a superiority over a modern field-glass as the difference in magnifying power would imply. In fact, if the reader will view the moon with a first-rate field-glass, he will perceive that the true nature of the surface of the lunar globe can be readily discerned with such an instrument. Even a small opera-glass will reveal much to the attentive observer of the moon ; but for these observations the reader should, if possible, make use of a field-glass, and the higher its power the better. The illustrations accompanying this article were made by the author with the aid of a glass magnifying six diameters.

Of course, the first thing the observer will wish to see will be the mountains of the moon, for everybody has heard of them, and the most sluggish imagination is stirred by the thought that one can look off into the sky and behold "the eternal hills" of another planet as solid and substantial as our own. But the chances are that, if left to their own guidance, ninety-nine persons out of a hundred would choose exactly the wrong time to see these mountains. At any rate, that is my experience with people who have come to look at the moon through my telescope. Unless warned beforehand, they invariably wait until full moon, when the flood of sunshine poured perpendicularly upon the face of our satellite conceals its rugged features as effectually as if a veil had been drawn over them. Begin your observations with the appearance of the narrowest crescent of the new moon, and follow it as it gradually fills, and then you will see how beautifully the advancing line of lunar sunrise reveals the mountains, over whose slopes and peaks it is climbing, by its ragged and sinuous outline. The observer must keep in mind the fact that he is looking straight down upon the tops of the lunar mountains. It is like a view from a balloon, only at a vastly greater height than any balloon has ever attained. Even with a powerful telescope the observer sees the moon at an apparent distance of several hundred miles, while with a field-glass, magnifying six diameters, the moon appears as if forty thousand miles off. The apparent distance with Galileo's telescope was eight thousand miles. Recollect how when seen from a great height the rugosities of the earth's surface flatten out and disappear, and then try to imagine how the highest mountains on the earth would look if you were suspended forty thousand miles above them, and you will, perhaps, rather wonder at the fact that the moon's mountains can be seen at all.

It is the contrast of lights and shadows that not only reveals them to us, but enables us to measure their height. On the moon shadows are very much darker than upon the earth, because of the extreme rarity of the moon's atmosphere, if indeed it has any atmosphere at all. By stepping around the corner of a rock there, one might pass abruptly from dazzling noonday into the blackness of midnight. The surface of the moon is extraordinarily rough and uneven. It possesses broad plains, which are probably the bottoms of ancient seas that have now dried up, but these cover only about two fifths of the surface visible to us, and most of the remaining three fifths are exceedingly rugged and mountainous. Many of the mountains of the moon are, foot for foot, as lofty as the highest mountains on the earth, while all of them, in proportion to the size of the moon's globe, are much larger than the earth's mountains. It is obvious, then, that the sunshine as it creeps over these Alpine landscapes in the moon, casting the black shadows of the peaks and craters many miles across the plains, and capping the summits of lofty mountains with light, while the lower regions far around them are yet buried in night, must clearly reveal the character of the lunar surface. Mountains that can not be seen at all when the light falls perpendicularly upon them, or, at the most, appear then merely as shining points, picture themselves by their shadows in startling silhouettes when illuminated laterally by the rising sun.

But at full moon, while the mountains hide themselves in light, the old sea-beds are seen spread out among the shining table-lands with great distinctness. Even the naked eye readily detects these as ill-defined, dark patches upon the face of the moon, and to their presence are due the popular notions that have prevailed in all quarters of the world about the "Man in the Moon," the "Woman in the Moon," "Jacob in the Moon," the "Hare in the Moon," the "Toad in the Moon," and so on. But, however clearly one may imagine that he discerns a man in the moon while recalling the nursery rhymes about him, an opera-glass instantly puts the specter to flight, and shows the round lunar disk diversified and shaded like a map.

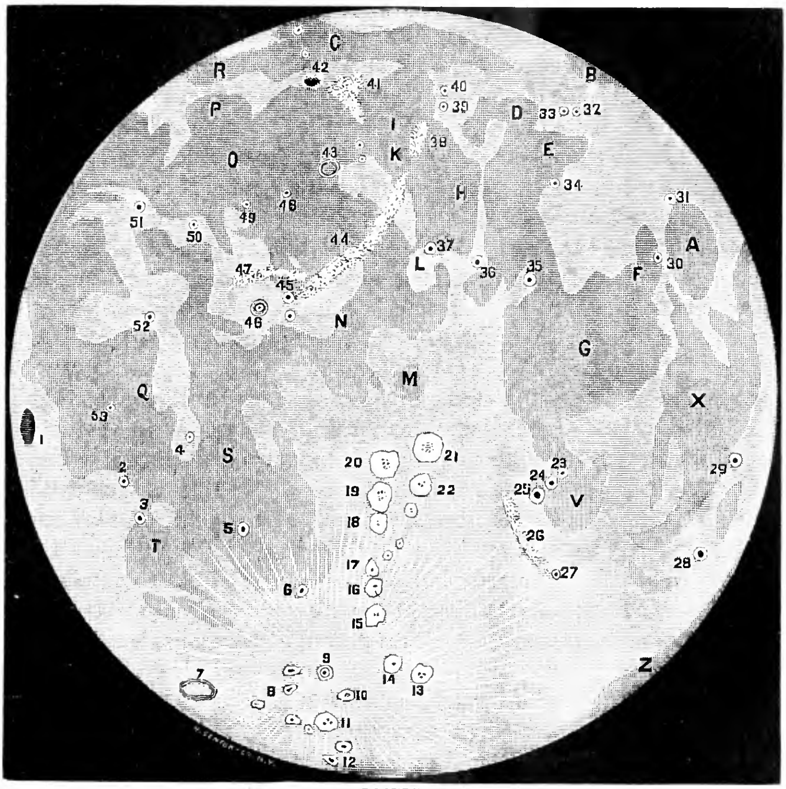
A feature of the full moon's surface that instantly attracts attention is the remarkable brightness of the southern part of the disk, and the brilliant streaks radiating from a bright point near the lower edge. The same simile almost invariably comes to the lips of every person who sees this phenomenon for the first time—"It looks like a peeled orange." The bright point, which is the great crater-mountain Tycho, looks exactly like the pip of the orange, and the light streaks radiating from it in all directions bear an equally striking resemblance to the streaks that one sees upon an orange after the outer rind has been removed. I shall have something more to say about these curious streaks farther on; in the mean time, let us glance at our first illustration, which is a small sketch-map of the moon.

The so-called seas are marked on the map, for the purpose of reference, by the letters which they ordinarily bear in lunar maps. The numerals indicate craters, or ring-plains, and mountain-ranges. The following key-list will enable the reader to identify all the objects that are lettered or numbered upon the map. I have given English translations of the Latin names which the old astronomers bestowed upon the seas:

NORTH

EAST

WEST




SOUTH

FIG. 1.—MAP OF THE MOON.

*Seas, Gulfs, and Marshes.*

A. The Crisian Sea.
B. Humboldt Sea.
C. The Sea of Cold.
D. The Lake of Death.
E. The Lake of Dreams.
F. The Marsh of Sleep.
G. The Sea of Tranquillity.
H. The Sea of Serenity.
I. The Marsh of Mists.
K. The Marsh of Putrefaction.
L. The Sea of Vapors.
M. The Central Gulf.
N. The Gulf of Heats.
O. The Sea of Showers.
P. The Bay of Rainbows
Q. The Ocean of Storms.
R. The Bay of Dew.
S. The Sea of Clouds.
T. The Sea of Humors.
V. The Sea of Nectar.
X. The Sea of Fertility.
Z. The South Sea.

*Mountains and Crater Rings.*

1. Grimaldi.
2. Letronne.
3. Gassendi.
4. Euclides.
5. Bullialdus.
6. Pitatus.
7. Schickhard.
8. Longomontanus.
9. Tycho.
10. Maginus
11. Clavius.
12. Newton.
13. Maurolycus.
14. Stöfler.
15. Walter.
16. Regiomontanus.
17. Purbach.
18. Arzachel.
19. Alphonsus.
20. Ptolemaus.
21. Hipparchus.
22. Albategnius.
23. Theophilus.
24. Cyrillus.
25. Catharina.
26. The Altai Mountains.
27. Piccolomini.
28. Petavius.
29. Langrenus.
30. Proclus.
31. Cleomedes.
32. Atlas.
33. Hercules.
34. Posidonius.
35. Plinius.
36. Menelaus.
37. Manilius.
38. The Caucasus Mountains.
39. Eudoxus.
40. Aristotle.
41. The Alps.
42. Plato.
43. Archimedes.
44. The Apennines.
45. Eratosthenes.
46. Copernicus.
47. The Carpathian Mts.
48. Timocharis.
49. Lambert.
50. Euler.
51. Aristarchus.
52. Kepler.
53. Flamsteed.

The early selenographers certainly must have been men of vivid imagination, and the romantic names they gave to the lunar landscapes, and particularly to the "seas," add a charm of their own to the study of the moon. Who would not wish to see the "Bay of

Rainbows," or the "Lake of Dreams," or the "Sea of Tranquillity," if for no other reason than a curiosity to know what could have induced men to give to these regions in the moon such captivating names? Or who would not desire to visit them if he could? though no doubt we should find them, like the "Delectable Mountains" in the "Pilgrim's Progress," most charming when seen from afar.

The limited scale of our map, of course, rendered it impossible to represent upon it more than a comparatively small number of the lunar mountains that have received names. In selecting those to be put in the map, I have endeavored to choose such as, on account of their size, their situation, or some striking peculiarity, would be most likely to attract the attention of a novice. The observer must not expect to see them all at once, however. The lunar features change their appearance to a surprising extent, in accordance with the direction of their illumination. Some great mountain-masses and ring-plains, or craters, which present scenes of magnificence when the sun is rising or setting upon them, disappear under a perpendicular light, such as they receive at full moon. The great crater-plain, known as Maginus, numbered 10 in our map, is one of these. The broken mountain-wall surrounding this vast depressed plain rises in some places to a height of over fourteen thousand feet above the valley within, and the spectacle of sunrise upon Maginus, seen with a powerful telescope, is a most impressive sight, and even with a field-glass it is very interesting. Yet, a few days later, Maginus vanishes, as if it had been swallowed up, and as Beer and Mädler have expressed it, "the full moon knows no Maginus." The still grander formation of mountain, plain, and crater, called Clavius (11 in the map), disappears almost as completely as Maginus at full moon, yet, under the proper illumination, it presents a splendid pageant of light and shadow.

On the other hand, some of the lunar mountains shine vividly at full moon, and can be well seen then, though, of course, only as light spots, since at that time they cast no shadows. Menelaus (36 in the map), Aristarchus (51), Proclus (30), Copernicus (46), and Kepler (52), are among these shining mountains. Aristarchus is the most celebrated of them all, being the brightest point on the moon. It can even be seen glimmering on the dark side of the moon—that is to say, when no light reaches it except that which is reflected from the earth. With a large telescope, Aristarchus is so dazzlingly bright under a high sun, that the eye is partly blinded in gazing at it. It consists of a mountain-ring surrounding a circular valley, about twenty-eight miles in diameter. The flanks of these mountains, especially on their inner slopes, and the floor of the valley within, are very bright, while a peak in the center of the valley, about as high as Storm King Mountain on the Hudson, shines with piercing brilliancy. Sir William Herschel mistook it for a volcano in action. It certainly is not an active volcano, but just what makes it so dazzling no one knows. The material of which this mountain is formed, would seem to possess a higher reflective power than that of any other portion of the moon's surface. One is irresistibly reminded of the crystallized mountains described in the celebrated "Moon Hoax" of Richard Adams Locke. With an opera-glass, you can readily recognize Aristarchus as a bright point at full moon. With a field-glass it is better seen, and some of the short, light rays surrounding it are perceived, while, when the sun is rising upon it, about four days after first quarter, its crateriform shape can be detected with such a glass.

Fig. 2.—Sunrise on the Sea of Serenity, and Theophilus and other Craters.

The visibility of Aristarchus on the dark side of the moon leads us to a brief consideration of the illumination by the earth of that portion of the moon's surface which is not touched directly by sunlight at new and old moon. This phenomenon is shown in our second illustration. Not only can the outlines of the dark part of the moon be seen under such circumstances, but even the distinction in color between the dusky "seas" and the more brilliant table-lands and mountain-regions can be perceived, and with powerful telescopes many minor features come into sight. A little consideration must convince any one, as it convinced Galileo more than two hundred and seventy-five years ago, that the light reflected from the earth upon the moon is sufficient to produce this faint illumination of the lunar landscapes. We have only to recall the splendors of a night that is lighted by a full moon, and then to recollect that at new or old moon the earth is "full" as seen from our satellite, and that a full earth must give some fourteen times as much light as a full moon, in order to realize the brilliancy of an earth-lit night upon the moon. As the moon waxes to us, the earth wanes to the moon, and *vice versa*, and so the phenomenon of earth-shine on the lunar surface must be looked for before the first quarter and after the last quarter of the moon.

The reader will find it an attractive occupation to identify, by means of the map, the various "seas," "lakes," and "marshes," for not only are they interesting on account of the singularity of their names, but they present many remarkable differences of appearance, which may be perceived with the instrument he is supposed to be using. The oval form of the Crisian Sea (A), which is the first of the "seas" to come into sight at new moon, makes it a very striking object. With good telescopes, and under favorable illumination, a decidedly green tint is perceived in the Crisian Sea. It measures about two hundred and eighty by three hundred and fifty-five miles in extent, and is, perhaps, the deepest of all the old sea-beds visible on the moon. It is surrounded by mountains, which can be readily seen when the sun strikes athwart them a few days after new or full moon. On the southwestern border a stupendous mountain-promontory, called Cape Agarum, projects into the Crisian Sea fifty or sixty miles, the highest part rising precipitously eleven thousand feet above the floor of the sea. I have seen Cape Agarum very clearly defined with a field-glass. Near the eastern border is the crater-mountain Proclus, which I have already mentioned as possessing great brilliancy under a high sun, being in this respect second only to Aristarchus.

From the foot of Proclus spreads away the somewhat triangular region called the Marsh of Sleep (F). The term "golden-brown," which has been applied to it, perhaps describes its hue well enough. With a telescope it is a most interesting region, but with less powerful instruments one must be content with recognizing its outline and color.

The broad, dark-gray expanse of the Sea of Tranquillity (G) will be readily recognized by the observer, and he will be interested in the mottled aspect which it presents in certain regions, caused by ridges and elevations, which, when this sea-bottom was covered with water, may have formed shoals and islands.

The Sea of Fertility (X) is remarkable for its irregular surface, and the long, crooked bays into which its southern extremity is divided.

The Sea of Nectar (V) is connected with the Sea of Tranquillity by a broad strait (one would naturally anticipate from their names that there must be some connection between them), while between it and the Sea of Fertility runs the range of the Pyrenees Mountains, twelve thousand feet high, flanked by many huge volcanic mountain-rings.

The Sea of Serenity (H), lying northeast of the Sea of Tranquillity, is about four hundred and twenty miles broad by four hundred and thirty miles long, being very nearly of the same area as our Caspian Sea. It is deeper than the Sea of Tranquillity, and a greenish hue is sometimes detected in its central parts. It deepens toward the middle. Three quarters of its shore-line are bordered by high mountains, and many isolated elevations and peaks are scattered over its surface. In looking at these dried-up seas of the moon, one is forcibly reminded of the undulating and in some places mountainous character of terrestrial sea-bottoms as shown by soundings and the existence of small islands in the deep sea, like the Bermudas, the Azores, and St. Helena. The Sea of Serenity is divided nearly through the center by a narrow, bright streak, apparently starting from the crater-mountain Menelaus (36 in the map), but really taking its rise at Tycho far in the south. This curious streak can be readily detected even with a small opera-glass. Just what it is no one is prepared to say, and so the author of the "Moon Hoax" was fairly entitled to take advantage of the romancer's license, and declare that "its edge throughout its whole length of three hundred and forty miles is an acute angle of solid quartz-crystal, brilliant as a piece of Derbyshire spar just brought from the mine, and containing scarcely a fracture or a chasm from end to end!" Along the southern shore, on either side of Menelaus, extends the high range of the Hæmus Mountains. South and southeast of the Sea of Serenity are the Sea of Vapors (L)*, the Central Gulf (M), and the Gulf of Heats (N). The observer will notice at full moon three or four curious dark spots in the region occupied by these flat expanses. On the north and northwest of the Sea of Serenity are the Lake of Death (D), and the Lake of Dreams (E), chiefly remarkable for their names.

The Sea of Showers (O) is a very interesting region, not only in itself, but on account of its surroundings. Its level is very much broken by low, winding ridges, and it is variegated by numerous light streaks. At its western end it blends into the Marsh of Mists (I) and the Marsh of Putrefaction (K). On its northeast border is the celebrated Sinus Iridum, or Bay of Rainbows (P), upon which selenographers have exhausted the adjectives of admiration. The bay is semicircular in form, one hundred and thirty-five miles long and eighty-four miles broad. Its surface is dark and level. At either end a splendid cape extends into the Sea of Showers, the eastern one being called Cape Heraclides, and the western Cape Laplace. They are both crowned by high peaks. Along the whole shore of the bay runs a chain of gigantic mountains forming the southern border of a wild and lofty plateau, called the Sinus Iridum Highlands. Of course, a telescope is required to see the details of this "most magnificent of all lunar landscapes," and yet much can be done with a good field-glass. With such an instrument I have seen the capes at the ends of the bay projecting boldly into the dark, level expanse surrounding them, and the high lights of the bordering mountains sharply con-

* The letter L has accidentally been misplaced in the map. It should be on the dark expanse below its present place.

trasted with the dusky semicircle at their feet, and have been able to detect the presence of the low ridges that cross the front of the bay like shoals, separating it from the "sea" outside. Two or three days after first quarter, the shadows of the peaks about the Bay of Rainbows may be seen. The Bay of Dew (R) above the Bay of Rainbows, and the Sea of Cold (C), are the northernmost of the dark levels visible. It was in keeping with the supposed character of this region of the moon that Riccioli named two portions of it the Land of Hoar Frost and the Land of Drought.

Extending along the eastern side of the disk is the great Ocean of Storms (Q), while between the Ocean of Storms and the middle of the moon lies the Sea of Clouds (S). Both of these are very irregular in outline, and much broken by ridges and mountains. The Sea of Humors (T), although comparatively small, is one of the most easily seen of all the lunar plains. To the naked eye it looks like a dark, oval patch on the moon. With a telescope it is seen, under favorable conditions, to possess a decided green tint. Humboldt Sea (B) and the South Sea (Z) belong principally to that part of the moon which is always turned away from the earth, and only their edges project into the visible hemisphere, although under favorable librations, their further borders, lined as usual with mountain-peaks, may be detected. For our purposes they possess little interest.

Let us now glance at some of the mountains and "craters." The dark oval called Grimaldi (1) can be detected by the naked eye, or at least it has been thus seen, although it requires a sharp eye; and perhaps a shade of London smoke-glass, to take off the glare of the moon, should be used in looking for it. It is simply a plain, containing some fourteen thousand square miles, remarkable for its dark color, and surrounded by mountains. Schickhard (7) is another similar plain, nearly as large, but not possessing the same dark tint in the interior. The huge mountains around Schickhard make a fine spectacle when the sun is rising upon them shortly before full moon.

Tycho (9) is the most famous of the crater-mountams, though not the largest. It is about fifty-four miles across and three miles deep, In its center is a peak five or six thousand feet high. Tycho is the radial point of the great light-streaks that, as I have already remarked, cause the southern half of the moon to be likened to a peeled orange. It is a tough problem in selenography to account for these streaks. They are best seen at full moon. They can not be seen at all until the sun has risen to a certain elevation above them, 25° according to Neison; but, when they once become visible, they dominate everything. They turn aside for neither mountains nor plains, but pass straight on their courses over the ruggedest regions of the moon, retaining their brilliancy undiminished, and pouring back such a flood of reflected light that they completely conceal some of the most stupendous mountain-masses across which they lie. They clearly consist of different material from that of which the most of the moon's surface is composed—a material possessing a higher reflective power. In this respect they resemble Aristarchus and other lunar craters that are remarkable for their brilliancy under a high illumination. Tycho itself, the center or hub, from which these streaks radiate like spokes, is very brilliant in the full moon. But immediately around Tycho there is a dark rim some twenty-five miles broad. Beyond this rim the surface becomes bright, and the bright region extends about ninety miles farther. Out of it spring the great rays or streaks which vary from ten to twenty miles in width, and many of which are several hundred miles long—one, which we have already mentioned as extending across the Sea of Serenity, being upward of two thousand miles in length. It has been truly said that we have nothing like these streaks upon the earth, and so there is no analogy to go by in trying to determine their nature. It has been suggested that if the moon had been split or shattered from within by some tremendous force, and molten matter from the interior had been thrust up into the cracks thus formed, and had cooled there into broad seams of rock, possessing a higher reflective power than the surrounding surface of the moon, then the appearances presented would not be unlike what we actually see. But there are serious objections to such a view, which we have not space to discuss here. It is enough to say that the nature of these streaks is still a question awaiting solution, and here is an opportunity for an important discovery, but one not to be achieved with an opera-glass.

Fig. 3.—Sunrise on Clavius, Tycho, Plato, Etc.

Clavius (11) is one of the most impressive of all the lunar formations. There probably does not exist anywhere upon the earth so wild a scene upon a corresponding scale of grandeur. Of course, its details are far beyond the reach of the instrument we are supposed to be using, and yet even with a field-glass, or a powerful opera-glass, some of its main features are visible. It is represented in our third illustration, being the lowest and largest of the ring-like forms seen at the inner edge of the illuminated half of the disk; the rays of the rising sun touching the summits of some of the peaks in its interior have brought them into sight as a point of light, and at the same time, reaching across the gulf within, have lighted up the higher slopes of the great mountain-wall on the farther or eastern side of the crater valley, making it resemble a semicircle of light projecting into the blackness of the still unilluminated plains around it. I should advise every reader to take advantage of any opportunity that may be presented to him to see Clavius with a powerful telescope when the sun is either rising or setting upon it. Neison has given a spirited description of the scene, as follows:

The sunrise on Clavius commences with the illumination of a few peaks on the western wall, but soon rapidly extends along the whole wall of Clavius, which then presents the appearance of a great double bay of the dark night-side of the moon penetrating so deep into the illuminated portion as to perceptibly blunt the southern horn to the naked eye. Within the dark bay some small, bright points soon appear—the summits of the great ring-plains within—followed shortly by similar light points near the center, due to peaks on the walls of the smaller ring-plains, these light islands gradually widening and forming delicate rings of light in the dark mass of shadow still enveloping the floor of Clavius. Far in the east then dimly appear a few scarcely perceptible points, rapidly widening into a thin bright line, the crest of the great southeastern wall of Clavius, the end being still lost far within the night-side of the moon. By the period the extreme summit of the lofty wall of Clavius on the east becomes distinct, fine streaks of light begin to extend across the dark mass of shadow on the interior of Clavius, from the light breaking through some of the passes on the west wall and illuminating the interior; and these streaks widen near the center and form illuminated spots on the floor, when both east and west it still lies deeply immersed in shadow, strongly contrasting with the now brightly-illuminated crest of the lofty east wall and the great circular broad rings of light formed by the small ring-plains within Clavius. The illumination of the interior of Clavius now proceeds rapidly, and forms a magnificent spectacle: the great brightly-illuminated ring-plains on the interior, with their floors still totally immersed in shadow; the immense steep line of cliffs on the east and southeast are now brilliantly illuminated, though the entire surface at their base is still immersed in the shades of night; and the great peaks on the west towering above the floor are thrown strongly into relief against the dark shadow beyond them.

Newton (12) is the deepest of the great crateriform chasms on the moon. Some of the peaks on its walls rise twenty-four thousand feet above the interior gulf. Its shadow, and those of its gigantic neighbors—for the moon is here crowded with colossal walls, peaks, and craters—may be seen breaking the line of sunlight below Clavius, in our third picture. I have just spoken of these great lunar formations as chasms. The word describes very well the appearance which some of them present when the line separating day and night on the moon falls across them, but the reader should not be led by it into an erroneous idea of their real character. Such formations as Newton, which is one hundred and forty miles long by seventy broad, may more accurately be described as vast depressed plains, generally containing peaks and craters, which are surrounded by a ring of steep mountains, or mountain-walls, that rise by successive ridges and terraces to a stupendous height.

The double chain of great crater-plains reaching half across the center of the moon contains some of the grandest of these strange configurations of conjoined mountain, plain, and crater. The names of the principal ones can be learned from the map, and the reader will find it very interesting to watch them coming into sight about first quarter, and passing out of sight about third quarter. At such times, with a field-glass, some of them look like enormous round holes in the inner edge of the illuminated half of the moon. Theophilus (23), Cyrillus (24), and Catharina (25), are three of the finest walled plains on the moon—Theophilus, in particular, being a splendid specimen of such formations. This chain of craters may be seen rapidly coming into sunlight at the edge of the Sea of Nectar, in our second illustration. The Altai Mountains (26) are a line of lofty cliffs, two hundred and eighty miles in length, surmounting a high table-land.

The Caucasus Mountains (38) are a mass of highlands and peaks, which introduce us to a series of formations resembling those of the mountainous regions of the earth. The highest peak in this range is about nineteen thousand feet. Between the Caucasus and the Apennines (44) lies a level pass, or strait, connecting the Sea of Serenity with the Sea of Showers. The Apennines are the greatest of the lunar mountain-chains, extending some four hundred and sixty miles in length, and containing one peak twenty-one thousand feet high, and many varying from twelve thousand to nearly twenty thousand. It will thus be seen that the Apennines of the earth sink into insignificance in comparison with their gigantic namesakes on the moon. As this range runs at a considerable angle to the line of sunrise, its high peaks are seen tipped with sunlight for a long distance beyond the generally illuminated edge about the time of first quarter. Even with the naked eye the sun-touched summits of the lunar Apennines may at that time be detected as a tongue of light projecting into the dark side of the moon. The Alps (41) are another mountain-mass of great elevation, whose highest peak is a good match for the Mont Blanc of the earth, after which it has been named.

Plato (42) is a very celebrated dark and level plain, surrounded by a mountain-ring, and presenting in its interior many puzzling and apparently changeable phenomena which have given rise to much speculation, but which, of course, lie far beyond the reach of opera-glasses. Plato is seen in our third illustration, being the second ring from the top.

Copernicus (46) is the last of the lunar formations that we shall describe. It bears a general resemblance to Tycho, and is slightly greater in diameter; it is, however, not quite so deep. It has a cluster of peaks in the center, whose tops may be detected with a field-glass, as a speck of light when the rays of the morning sun, slanting across the valley, illuminate them while their environs are yet buried in night. Copernicus is the center of a system of light-streaks somewhat resembling those of Tycho, but very much shorter.

We must not dismiss the moon without a few words as to its probable condition. It was but natural, after men had seen the surface of the moon diversified with hills and valleys like another earth, that the opinion should find ready acceptance that beings not unlike ourselves might dwell upon it. Nothing could possibly have been more interesting than the realization of such a fancy by the actual discovery of the lunar inhabitants, or at least of unmistakable evidence of their existence. The moon is so near to the earth, as astronomical distances go, and the earth and the moon are so intimately connected in the companionship of their yearly journey around the sun, and their greater journey together with the sun and all his family, through the realms of space, that we should have looked upon the lunar inhabitants, if any had existed, as our neighbors over the way, dwelling, to be sure, upon a somewhat more restricted domain than ours, vassals of the earth in one sense, yet upon the whole very respectable and interesting people, with whom one would be glad to have a closer acquaintance. But, alas! as the powers of the telescope increased, the vision of a moon crowded with life faded, until at last the cold fact struck home that the moon is, in all probability, a frozen and dried-up globe, a mere planetary skeleton, which could no more support life than the Humboldt glacier could grow roses. And yet this opinion may go too far. There is reason for thinking that the moon is not absolutely airless, and, while it has no visible bodies of water, its soil may, after all, not be entirely arid and desiccated. There are observations which hint at visible changes in certain spots that could possibly be caused by vegetation, and there are other observations which suggest the display of electric luminosity in a rarefied atmosphere covering the moon. To declare that no possible form of life can exist under the conditions prevailing upon the lunar surface would be saying too much, for human intelligence can not set bounds to creative power. Yet, within the limits of life, such as we know them, it is probably safe to assert that the moon is a dead and deserted world. In other words, if a race of beings resembling ourselves, or resembling any of our contemporaries in terrestrial life, ever existed upon the moon, they must long since have perished. That such beings may have existed is possible, particularly if it is true, as generally believed, that the moon once had a comparatively dense atmosphere and water upon its surface, which have now, in the process of cooling of the lunar globe, been withdrawn into its interior. It certainly does not detract from the interest with which we study the rugged and beautiful scenery of the moon to reflect that if we could visit those ancient sea-bottoms, or explore those glittering mountains, we might, perchance, find there some remains or mementoes of a race that flourished, and perhaps was all gathered again to its fathers, before man appeared upon the earth.

That slight physical changes, such as the downfall of mountain-walls or crater-cones, still occasionally occur upon the moon, is an opinion entertained by some selenographers, and apparently justified by observation. The enormous changes of temperature, from burning heat under a cloudless sun to the freezing cold of space at night with no atmospheric blanket to retain heat (which has generally been assumed to be the condition of things on the moon), would be expected to exert a disintegrating effect upon the lunar rocks. But the question is now in dispute whether the surface of the moon ever rises above the freezing-point of water, even under a midday sun.

THE SUN.—That spots upon the sun may be seen with no greater optical aid than that of an opera-glass is perhaps well known to many of my readers, for during the past half-dozen years public attention has been drawn to sun-spots in an especial manner, on account of their supposed connection with meteorology, and in that time there have been many spots upon the solar disk which could not only be seen with an opera-glass, but even with the unassisted eye. At present we are approaching a minimum period of sun-spots, and the number to be seen even with a telescope is comparatively very small, yet only a few days before this page was written there was a spot on the sun large enough to be conspicuous with the aid of a field-glass. During the time of a spot-maximum the sun is occasionally a wonderful object, no matter how small the power of the instrument used in viewing it may

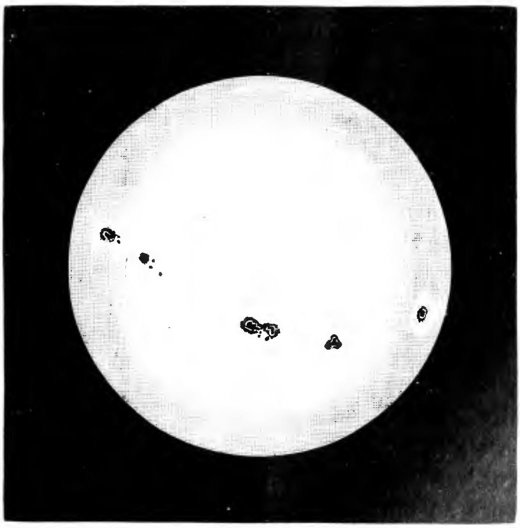


FIG. 4.—THE SUN, SEPTEMBER 1, 1883.

be. Strings of spots of every variety of shape sometimes extend completely across the disk. Our fourth illustration shows the appearance of the sun, as drawn by the author on the 1st of September, 1883. Every one of the spots and spot-groups there represented could be seen with a good field-glass, and nearly all of them with an opera-glass.

As in all such cases, our interest in the phenomena increases in proportion to our understanding of their significance and their true scale of magnitude. In glancing from side to side of the sun's disk, the eye ranges over a distance of more than 860,000 miles—not a mere ideal distance, or an expanse of empty space, but a distance filled by an actual and, so to speak, tangible body, whose diameter is of that stupendous magnitude. One sees at a glance, then, the enormous scale on which these spots are formed. The earth placed beside them would be but a speck, and yet they are mere pits in the surface of the sun, filled perhaps with partially cooled metallic vapors, which have been cast up from the interior, and are settling back again. It is worth anybody's while to get a glimpse at a sun-spot if he can, for, although he may see it merely as a black dot on the shining disk, yet it represents the play of physical forces whose might and power are there exercised on a scale really beyond human comprehension. The imagination of Milton or Dante would have beheld the mouth of hell yawning in a sun-spot.

In order to view the sun, it is, of course, necessary to contrive some protection for the eyes. This may be constructed by taking two strips of glass four or five inches long and an inch wide, and smoking one of them until you can without discomfort look at the sun through it. Then place the two strips together, with the smoked surface inside—taking care to separate them slightly by pieces of cardboard placed between the ends—and fasten the edges together with strips of paper gummed on. Then, by means of a rubber band, fasten the dark glass thus prepared over the eye-end of your opera-glass in such a way that both of the lenses are completely covered by it. It will require a little practice to enable you to get the sun into the field of view and keep it there, and for this purpose you should assume a posture—sitting, if possible—which will enable you to keep the glass very steady. Then point the glass nearly in the direction of the sun, and move it slowly about until the disk comes in sight. It is best to carefully focus your glass on some distant object before trying to look at the sun with it.

As there is some danger of the shade-glass being cracked by the heat, especially if the object-glasses of the instrument are pretty large, it would be well to get the strips of glass for the shade large enough to cover the object-end of the instrument instead of the eye-end. At a little expense an optician will furnish you with strips of glass of complementary tints, which, when fastened together, give a very pleasing view of the sun without discoloring the disk. Dark red with dark blue or green answer very well; but the color must be very deep. The same arrangement, of course, will serve for viewing an eclipse of the sun.

# MANUAL TRAINING IN SCHOOL EDUCATION.

BY SIR PHILIP MAGNUS.

"Manual labor is the study of the external world."—EMERSON.

THE first object of education being to bring the mind of man into direct relation with its surroundings, and as this communion is only possible through the senses, the importance of the cultivation of the senses is duly insisted upon by all educational authorities. Now, of the several organs through which we obtain a knowledge of the external world, the sense of touch and the muscular sense have a certain prominence as giving us perceptions which are mainly intellectual. For this reason we should expect that the training of the muscular and tactile sensibility of the hand, and the training of the muscular sense generally, as exercised in the determination of size, shape, and resistance, would form an essential factor of education. But so little has this been the case that, until comparatively recent times, the training of the faculties by which we obtain, at first hand, our knowledge of the things about us has been sadly neglected, and education has consisted mainly in storing the memory with words, with the statements and opinions of others, and with inferences therefrom. Apart altogether from the value of the constructive power which manual skill affords, the knowledge of the properties of matter which is obtained in the acquisition of that skill is considerable, and can not be equally well acquired in any other way. It is this which gives to manual training its value as an educational discipline, and it is mainly for this reason that it is coming to be regarded as an important part of the educational system of nearly every country. "The introduction of manual work into our schools is important," says Sir John Lubbock, "not merely from the advantage which would result to health, not merely from the training of the hand as an instrument, but also from its effect on the mind itself." * And it is to this effect on the mind that I desire to call especial attention in this article.

By manual training one commonly means exercises in the use of the tools employed in working wood and iron.

It can not be too often repeated that the object of workshop practice, as a part of general education, is not to teach a boy a trade, but to develop his faculties and to give him manual skill; that, although the carpenter's bench and the turner's lathe are employed as instruments of such training, the object of the instruction is not to create carpenters or joiners, but to familiarize the pupil with the properties of such common substances as wood and iron, to teach the hand and eye to work in unison, to accustom the pupil to exact measurements,

* "Fortnightly Review," October, p. 467.

and to enable him by the use of tools to produce actual things from drawings that represent them. The discipline of workshop instruction may be regarded as supplementary to that of drawing, with which, however, it should always be associated, as teaching a knowledge of *substance* in addition to that of *form*. Moreover, under competent instructors, it may be made an instrument of education similar, in many respects, to practical science. In the workshop, the operations to be performed are less delicate, the measurements are not required to be so exact, the instruments are more easily understood, the substances employed are more ordinary; but the training is very similar, and in so far as the faculties exercised are those of observation rather than of inference, the training, educationally considered, is a fitting introduction to laboratory practice. At the same time, the skill acquired in the workshop is particularly serviceable to the laboratory student in enabling him to make and fit apparatus, and in giving him that adroitness on which progress in scientific work so much depends. But while a certain amount of manual training is valuable in the education of all classes of persons—a fact which is already recognized by the head-masters of several of our best secondary schools—the usefulness of this kind of training is much greater in the case of the children of the working-classes, whose education is too limited and often too hurried to admit of any practical science-teaching, such as older children obtain, and to whom the skill acquired is of real advantage in inducing in them an aptitude and taste for handicrafts, in facilitating the acquisition of a trade, and possibly in shortening the period of apprenticeship, or of that preliminary training which in so many occupations takes the place of it.

An objection is sometimes raised to the introduction of manual training into elementary schools on the ground that, as the children of the working-classes necessarily leave school at an early age, and spend their lives for the most part in manual work, such time as they can give to study should be occupied in other pursuits—in cultivating a taste for reading, and in the acquisition of book-knowledge. This objection is due to a misconception of the true objects and aims of education, and to an imperfect knowledge of what is meant by workshop instruction. To assume that the best education can be given through the medium of books only, and can not be equally well obtained from the study of things, is a survival of the mediævalism against which nearly all modern educational authorities protest. But there is another and more deeply-rooted error in this argument. People often talk and write as if school-time should be utilized for teaching those things which a child is not likely to care to learn in after-life; whereas the real aim of school education should be to create a desire to continue in after-life the pursuit of the knowledge and the skill acquired in school. In other words, the school should be made, as far as possible, a preparation for the whole work of life, and should naturally lead up to it. The endeavor of all educators should be to establish such a relation between school instruction and the occupations of life as to prevent any break of continuity in passing from one to the other. The methods by which we gain information and experience in the busy world should be identical with those adopted in schools.

It is because the opposite theory has so long prevailed, that our school-training has proved so inadequate a preparation for the real work of life. This was not the case in former times; and the demand for technical instruction, both in our elementary and in our secondary schools, is a protest against the contrast which has so long existed between the subjects and methods of school-teaching and the practical work of every-day life.

We are always justly complaining that in this country children leave school at too young an age, before they can have had time to properly assimilate the knowledge they have acquired, with the result that they soon forget a great part of the little they have learned. At the age of fifteen or sixteen, when they begin to feel the want of technical instruction, they are wholly unprepared to avail themselves of the opportunities for obtaining it now brought within their reach. It is to remedy this state of things that continuation schools and recreative classes are much needed. But there can be little doubt, if elementary education were made more practical, that parents would be more willing, even at some sacrifice, to let their children benefit by it. They are often led to take their children away from school, because they do not see much use in the "schooling." Of course, the desire to secure the child's early earnings operates in very many cases; but I am convinced that it would be easier to persuade parents to forego these earnings, if the school-teaching had more direct reference to the work in which the children are likely to be subsequently occupied.

Now, in order that manual training may serve the purpose of an intellectual discipline, the methods of instruction must be carefully considered. That the training of the hand and eye, and the development of the mental faculties, are the true objects of the instruction should never be lost sight of. In many respects, the instruction should partake of the character of an ordinary object-lesson. Before the pupil commences to apply his tools to the material in hand, he should learn something of its nature and properties. The teacher, in a few words introductory to each lesson, should explain to his pupils the distinguishing characteristics of different kinds of wood, as met with in the shop and as found in Nature, and also the differences in the structure and properties of wood according to its sections, treatment, etc. And he should illustrate his lessons by reference to specimens and examples, a collection of which should be found in every school workshop. Something should be said of the countries from which timber is imported, and the conditions under which it is bought and sold, and in this way the material to be manipulated should be made the center of a series of scientific object-lessons.

Concurrently with the practice in the use of any tool, the pupil should learn its construction, the reason of its shape, and the history of its development from other simpler forms. The saw, the plane, the chisel, and the calipers should each be made the subject of an object-lesson to the pupils. In the same way, the teacher should explain the purposes of the different parts of constructive work, and should have models of tenon, mortise, dovetailing, and other joints to illustrate his explanations.* Fifteen or twenty minutes thus spent might be made the means of stimulating the intelligence and of exercising the observing and reasoning faculties of the children, and of enabling them to fully understand the work they are doing and the instruments they are using.

Further, the children should be taught, from the very first, to work from correct scale-drawings, made by themselves from their own rough sketches. How simple soever the object may be which the pupil is to construct, it should exactly correspond with his own drawings. In this way, the workshop instruction supplements and gives a meaning to the drawing-lesson, and the school-teaching is made to have a direct bearing upon the subsequent work of the artisan. Dr. Woodward, the instructor of the St. Louis Manual Training-School, who has had considerable experience in organizing and superintending workshop instruction, tells us that "the habit of working from drawings and to nice measurements gives to students confidence in themselves altogether new"; and he justly claims that "it is the birthright of every child to be taught the three methods of expression: 1. By the written, printed, or spoken word. 2. By the pencil and brush, using the various kinds of graphic art. 3. Through the instrumentality of tools and materials, which enable one to express thought in the concrete." † The Committee of Council on Education, in their recent report, speaking of the teaching of cooking to girls, say: "After the three elementary subjects and sewing, no subject is of such importance for the class of girls who attend public elementary schools, and lessons in it, if properly given, will be found to be not only of practical use, but to have the effect of awakening the interest and intelligence of the children." Surely, what is true of sewing and cooking in the case of girls, is true to a greater extent of drawing and handicrafts in the case of boys.

In many parts of the Continent manual training has now for some years been associated with elementary instruction. In France, Belgium, Austria, Holland, and Sweden the workshop is a part of the school-building; and in the United States the number of manual training-schools of higher grade, somewhat similar to the well-known ap-

* Collections of these models for school purposes are sold by Messrs. Schröder, of Darmstadt.

† "Proceedings of International Conference on Education," London, 1884, vol. ii, p. 58.

prenticeship-schools of France, is steadily increasing. Indeed, judging from the published accounts of these schools, and from the writings of some of the most prominent educationists in the United States, an enthusiasm is spreading among Americans in favor of workshop instruction, which is likely to have an important influence on the industrial progress of this eminently practical and inventive people.

In the report of the Commissioners on Technical Instruction, notices will be found of some of the principal Continental schools which are now fitted with workshops. Sir John Lubbock, in the article above quoted, has supplemented this information by reference to the "Slöjd" system of manual instruction which is adopted in Sweden. An interesting account of this system has been written by M. Sluys, who is well known to educationists from his connection with the École Modèle of Brussels. Since the report of the commissioners was published, the movement in favor of workshop-teaching in schools has advanced rapidly in France. Nearly every large town has now its higher elementary school (a type of school as yet scarcely to be found in this country) fitted with workshops for wood and iron; and, out of one hundred and seventy-four primary schools supported by the city of Paris, ninety-five are now provided with workshops, ninety for instruction in carpentry and wood-turning, and five for metal-work. In these schools the manual teaching has hitherto been given either before or after the ordinary school-hours; but the Municipal Council of Paris attach such importance to this training that it is proposed to make the workshop instruction a part of the regular school curriculum. This change will necessitate a rearrangement of the school-hours and the provision of workshops in the remaining seventy-nine schools in which they have not yet been fitted. But it is confidently expected that the municipality of Paris, which has done so much for the technical education of its artisans, will not hesitate to incur this additional expense. The action of the city of Paris gives additional weight to the recommendation of the English commissioners on this subject.

Experiments of introducing workshops into elementary schools have been tried in this country, with results sufficiently encouraging to justify the extension of the system. In Sheffield, Birmingham, and Glasgow the results have been eminently satisfactory. In London the experiment has recently been tried on a small scale, and under not the most favorable circumstances, in the Beethoven Street schools; but the report of Mr. Tate, the energetic head-master, is so encouraging that the School Board of London is very desirous of extending the system of instruction to a large number of the schools under its control. In his report to the board, Mr. Tate says:

> This class was started on September 28, 1885, in a shed or workshop built by the board in a recess in the playground, and the instruction is given by the school-keeper, a carpenter by trade, under the direct supervision of the head-master.

The boys are chosen mainly from the seventh standard, and attendance at the workshop is considered a privilege, and a reward of merit in ordinary school subjects. It is therefore a simulus and incentive to industry and thoroughness of work. This plan has been so effective that a boy once chosen values the teaching and practice so much that he continues to be chosen each week, and the instruction is therefore continuous, for the class has been virtually the same since it started.

Boys who have been trained in a good school, and have acquired soundly the rudiments of education, too often when they leave school think that their proper career is a city counting-house, and that to wear black clothes and appear as a gentleman is a fair summit of their ambition. I certainly think that this workshop for upper standard boys will help to dissipate this idea, as it will show boys that, after we have given them the best education which the school offers, we then lead them into the workshop, and so practically show them that the end and aim of our training is to enable them to learn some useful trade, and so become good workmen.

The workshop, I believe, is a valuable training to enable the eye and hand to work in harmony. It is intended to make the school-drawing, especially the scale-drawing and geometry, apply as much as possible to the work done in the workshop. It is certainly a pleasant relief to ordinary school-work. Should a boy not follow a trade when he leaves school, he will at least be able to make his home-work comfortable by using the skill and facility which he has acquired in this workshop.

At the expense of the Rev. S. Barnett and a few of his friends, a workshop has recently been fitted in the school attached to St. Jude's Church, Whitechapel. Arrangements have been made for giving instruction in carpentry and turnery to boys, and in modeling and wood-carving to girls of the upper standards, and the results of the lessons have fully justified the most sanguine expectations of the advocates of this kind of instruction. Those who have visited these schools have been struck with the cheerful interest shown by the children in their work, and by the effect of the teaching in quickening their perceptive faculties and in stimulating their intelligence. The contrast between the listless and often inattentive attitude of children, occupied with some ordinary class lesson, and the eager eyes and nimble fingers of the same children at the carpenter's or modeling bench is most instructive; and no one who has seen it can have any doubt of the educational value of this kind of training. These results, it must be remembered, have been attained by teachers most of whom have themselves been trying experiments, and have been working by the light of Nature without any well-considered methods. Under properly-trained instructors, the results would doubtless have been far more satisfactory.

There is good reason to believe that the stimulating effect of workshop instruction on the intelligence of children will be such that, notwithstanding the loss of the time spent in the shop, their progress in their ordinary studies will be in no way retarded.

Mr. Swire Smith, a member of the late Commission on Technical

Instruction, states "that the half-time children of the town of Keighley, numbering from fifteen hundred to two thousand, although they receive less than fourteen hours of instruction per week, and are required to attend the factory for twenty-eight hours per week in addition, yet obtain at the examinations a higher percentage of passes than the average of children throughout the whole country receiving double the amount of schooling." This answers the objection so often raised, that the curriculum of elementary schools is already overcrowded. Possibly it may be with literary studies, but not with practical work, and the combination of the two will go far to correct the tendency to over-pressure inherent in our system of payment by results.

As a general rule, children should be required to have passed the fifth standard before being admitted into the shop. They should receive two lessons a week, and each lesson should be of about two hours' duration. No fixed rule can at present be given as to the number of children who can be taught by one instructor. For convenience of supervision the shop should be fitted for the accommodation of not more than twenty-five children. On starting a class, each pupil requires more individual attention than later on. A class of beginners, therefore, should not consist of the full complement of children. Where the same shop is used for bench-work and lathe-work, it will be found that a double lathe will occupy four pupils, that eighteen can be accommodated at three carpenters' benches, each of not less than fourteen feet six inches in length, while two may be engaged in sawing. Besides the benches and lathes, the school should contain a large blackboard, a cupboard, which is better than boxes for holding tools, and a grindstone.

In estimating the expense of adding this subject to our elementary school course, we have to consider the cost—first, of equipping the workshops ; second, of the material used ; third, of the teaching.

Supposing a shed or some other room to be found, which can be used as a workshop, the cost of equipping the shop with benches and with the necessary tools need not exceed thirty shilling for each pupil's place, and the workshop can be used by different sets of pupils at different times. Moreover, a shop need not be fitted at once with the full complement of benches ; for, after a time, the more advanced pupils may be employed in making some of the additional fittings required.

The cost of material is inconsiderable. The children soon learn to construct various articles for their own homes, which, on payment of the cost of the material consumed, become the property of their parents. Some, too, might be employed in making models and other objects, including certain workshop-fittings, which might be purchased for the use of other schools. At the same time, care must be taken that the work is always subordinated to the educational purpose of the instruction.

Of the actual cost of the teaching no very exact estimate can as yet be formed. Much depends on the system adopted. If the instruction were given during school-hours, it would take the place of some other lesson, and, by a proper arrangement of time-tables, might be given at very little additional expense. In some of the schools in which the experiment has been already tried, special teachers have been appointed, who have received a certain fee for each lesson. But if several schools in the same district combined, one teacher might be engaged, and either the children might be brought to a common center, as in the case of the cookery-classes, or the teacher might go from school to school, as in the case of the science-teaching in Birmingham and Liverpool. The latter plan might be more convenient for the schools ; but the former plan would be more economical, as enabling one shop and certain tools to be used by several sets of children.

It would be necessary under any circumstances that the instruction should be encouraged by a system of grants, or by some equivalent external aid. A system might be organized of paying grants on the results of the individual work of each pupil ; but all the disadvantages of the method of "payment by results" would be emphasized in the case of workshop instruction, and the teaching would lose much of its disciplinary value. The amount of the grant should depend mainly on the average number of children in attendance. A grant of four shillings, as in the case of cookery-lessons, and the recognition of the subject by the Education Department, would afford sufficient encouragement to induce certain school boards and school managers to make manual training a part of the curriculum of the schools under their control. The total amount of these grants would be but a slight addition to our education expenses. According to the last report, the whole number of children presented for examination in the sixth and seventh standards was 112,455. Of these, we may assume that about 60,000 are boys. Supposing half this number to elect to receive workshop instruction, the grant would amount to £6,000 a year. But even this estimate is excessive as an addition to our present expenditure. For many of the children might take handicrafts in lieu of one of the specific subjects on which grants are now paid.* It may, therefore, I think, be asserted that, the workshops being once equipped, the additional cost in grants of introducing handicraft teaching into the curriculum of our elementary schools would not exceed £5,000 a year ; and for this comparatively small expenditure about 30,000 boys might be annually sent out into the world from our elementary schools endowed with practical skill at their fingers' ends, imbued with a taste

* It may be well here incidentally to call attention to the relatively small amount of grants earned for specific subjects. Out of 352,860 children, who last year were examined in elementary subjects in the fifth, sixth, and seventh standards, only 64,376 presented themselves in specific subjects, the total amount of grant paid being £14,662 11*s.* 8*d.* Of the children on account of whom these grants were earned, Sir John Lubbock tells us that less than 25,000 were examined in any branch of science.

and aptitude for the real work of their life, and so educated as to be able to apply to that work the results of scientific teaching and scientific methods.

In organizing a scheme of technical teaching in connection with our elementary schools, the difficulty has to be met of obtaining good teachers and competent inspectors. The artisan, who is a skillful workman and nothing more, may succeed in teaching the elements of carpentry and joinery; but he is not the kind of teacher needed. It is of the utmost importance that the instructor should be a good draughtsman, should have some knowledge of physical science, should be an expert workman, and should have studied the art of teaching. To obtain at first such ideal instructors would be impossible; but there is no reason why, gradually, they should not be trained. Two processes suggest themselves. We might take a well-trained elementary teacher, having an aptitude for mechanical arts, and give him a course of instruction in the use of tools, either in a technical school or in an ordinary workshop; or, we might take an intelligent artisan, who had studied science and drawing in some of the excellent evening classes which are now found in almost every town, and give him a short course of lessons on method in relation to workshop instruction. Good teachers might be obtained by either of these processes. Perhaps the latter is preferable, as it is most important that the teacher who is to inspire confidence should be a good workman to start with and thoroughly familiar with the practice of his trade. For such intelligent and educated artisans there is, I hope, a future of profitable employment. It would be well, however, that in all our technical colleges opportunities should be afforded to teachers in elementary schools of acquiring practice in the use of tools; and that special training-classes should be formed for artisans, in the organization of workshops and in the best methods of workshop teaching.

Nearly all educationists have pointed out the many advantages of enabling children at an early age to realize the connection between *knowing* and *doing*. Comenius has well said, "Let those things that have to be done be learned by doing them." Rousseau has pithily expressed a similar idea in saying: "Souvenez-vous qu'en toute chose vos leçons doivent être plus en actions qu'en discours; car les enfants oublient aisément ce qu'ils ont dit et ce qu'on leur a dit, mais non pas ce qu'ils ont fait et ce qu'on leur a fait." (Remember that in everything your lessons ought to be more in actions than in speech; for children easily forget what they have said and what has been said to them, but not what they have done and what has been done to them.) Locke, speaking of the education of a gentleman—for in his day the education of the poorer classes was scarcely thought of—says, "I would have him learn a trade, a manual trade"; and Emerson, in the choice words, "Manual labor is the study of the external world," tersely states the whole aim and purpose of my remarks. Rabelais, Montaigne, Pestalozzi, Froebel, Combe, Spencer, and others have urged the importance of practical teaching, of studying things before words, of proceeding from the concrete to the abstract. But, as yet, such has been the inertia of school authorities and teachers, and such the force of tradition, that we are only now beginning to employ the methods of instruction that have been advocated for years by the most eminent educational reformers.

In what I have said, I have endeavored to show that workshop instruction may be made a part of a liberal education; that, as an educational discipline, it serves to train the faculties of observation, to exercise the hand and eye in the estimation of form and size, and the physical properties of common things; that the skill acquired is useful in every occupation of life, and is especially serviceable to those who are likely to become artisans, by inducing taste and aptitude for manual work, by tending to shorten the period of apprenticeship, by enabling the learner to apply to the practice of his trade the correct methods of inquiry which he has learned at school, and by affording the necessary basis for higher technical education.

Possibly, the latest authoritative expression of opinion on the importance of manual training was a resolution, unanimously agreed to at the International Congress on Commercial and Technical Education, recently held at Bordeaux, to the effect that it is desirable that manual work should be rendered obligatory in primary schools of all grades.

It is satisfactory to know, from a circular* that has recently been sent to school managers, that this important subject is engaging the serious attention of the Royal Commission on Education now sitting, whose labors, it is to be hoped, may result in making our elementary teaching more practical, less mechanical, and better adapted to the future requirements of the working-classes.—*Contemporary Review.*

* The circular, as published by Lord Brabazon in a letter to the "Times" of October 11th, contains the following questions:

1. Is the course of teaching prescribed by the Code suited to the children of your school?

2. What changes, if any, would you desire in the (Education Acts)? in the Code? in the administration?

3. Would you recommend the introduction into your school of practical instruction? A. In any of the industries of the district? or in the use of tools for working in wood or iron? B. (for girls) in the domestic duties of home?

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Baron Eggers is about to undertake the botanical investigation of the hitherto unexplored higher mountains of Santo Domingo. He is under commission of Dr. Urban, assisted by the Royal Academy of Sciences of Berlin. Collections will be distributed in limited numbers, at prices bearing relation to the novelty of the species.

# THE PROGRESS OF SCIENCE FROM 1836 TO 1886.

By GRANT ALLEN.

FIFTY years ago, science was still inchoate. Much had already been done by the early pioneers. The ground had been cleared; the building-materials had been in part provided; the foundations had been duly and ably laid; but the superstructure as yet had hardly been raised a poor foot or two above the original level. The work of the last half-century has been twofold. On one side it has been accumulative merely: new stocks of organizable material—the raw bricks of science—have been laid up, as before, ready to the call of the master-mason, but in far greater profusion than by any previous age. On the other side it has been directive and architectonic; the endless stores of fact and inference, thus dug out and shaped to the hand by the brick-makers of knowledge in a thousand fields, have been assiduously built up by a compact body of higher and broader intelligences into a single grand harmonious whole. This last task forms, indeed, the great scientific triumph of our epoch. Ours has been an age of firm grasp and of wide vision. It has seen the downfall of the anthropocentric fallacy. Cosmos has taken the place of chaos. Isolated facts have been fitted and dovetailed into their proper niche in the vast mosaic. The particular has slowly merged into the general, the general into still higher and deeper cosmical concepts. We live in an epoch of unification, simplification, correlation, and universality. When after-ages look back upon our own, they will recognize that in science its key-note has been the idea of unity.

Fifty years ago, there were many separate and distinct sciences, but hardly any general conception of science at large as a single, rounded, and connected whole. Specialists rather insisted pertinaciously on the utter insularity of their own peculiar and chosen domain. Zoölogists protested, with tears in their eyes, that they had nothing to do with chemistry or with physics; geologists protested with a shrug of their shoulders, that they had nothing to do with astronomy or with cosmical genesis. It was a point of honor with each particular department, indeed, not to encroach on the territory of departments that lay nearest to it. Trespassers from the beaten path of the restricted science were prosecuted with the utmost rigor of the law. And within the realm of each separate study, in like manner, minor truths stood severely apart from one another; electricity refused to be at one with magnetism, and magnetism was hardly on speaking terms with the voltaic current. Organization and subordination of part to whole had scarcely yet begun to be even aimed at. The sciences were each a huge congeries of heterogeneous facts or unassorted laws; they waited the advent of their unknown Newtons to fall into systematic and organic order.

In the pride of our hearts, we forget for the most part how very young science still is. We—who have seen that infant Hercules strangling serpents almost from its very cradle; we, who have beheld it grow rapidly under our own eyes to virile maturity and adult robustness of thew and muscle—we forget how new a power it is in the world, and how feeble and timid was its tender babyhood in the first few decades of the present century. Among the concrete sciences, astronomy, the eldest-born, had advanced furthest when our age was still young. It had reached the stage of wide general laws and evolutionary aspirations. But geology had only just begun to emerge from the earliest plane of puerile hypothesis into the period of collection and colligation of facts. Biology, hardly yet known by any better or truer name than natural history, consisted mainly of a jumble of half-classified details. Psychology still wandered disconsolate in the misty domain of the abstract metaphysician. The sciences of man, of language, of societies, of religion, had not even begun to exist. The antiquity of our race, the natural genesis of arts and knowledge, the origin of articulate speech, or of religious ideas, were scarcely so much as debatable questions. Among sciences of the abstract-concrete class, physics, unilluminated by the clear light of the principles of correlation and conservation of energy, embraced a wide and ill-digested mass of separate and wholly unconnected departments. Light had little enough to do with heat, and nothing at all to do in any way with electricity, or sound, or motion, or magnetism. Chemistry still remained very much in the condition of Mrs. Jellaby's cupboard. Everywhere science was tentative and invertebrate, feeling its way on earth with hesitating steps, trying its wings in air with tremulous fear, in preparation for the broader excursions and wider flights of the last three adventurous decades.

The great campaign of the unity and uniformity of Nature was the first to be fought, and in that campaign the earliest decisive battle was waged over the bloody field of geology. In 1837—to accept a purely arbitrary date for the beginning of our epoch—Lyell had already published his sober and sensible "Principles," and the old doctrine of recurrent catastrophes and periodical cataclysms was tottering to its fall in both hemispheres. Wholesale destructions of faunas and floras, wholesale creations of new life-systems, were felt to be out of keeping with a humane age. Drastic cosmogonies were going out of fashion. But even the uniformitarianism for which Lyell bravely fought and conquered, was, in itself, but a scrappy and piecemeal conception side by side with the wider and far more general views which fifty years have slowly brought to us. One has only, to open the "Text-Book of Geology," by Lyell's far abler modern disciple, Archibald Geikie, in order to see the vast advance made in our ideas as to the world's history during the course of the last half-century. The science of the earth's crust no longer stands isolated as a study by itself: it falls into its proper place in the hierarchy of knowledge as the science of the secondary changes, induced under the influence of internal forces and incident energies, on the cooling and corrugated surface of a once incandescent and more extended planet. I know no better gauge of the widening which comes over the thoughts of men with the processes of the suns than to turn from the *rudis indigestaque moles* of the "Principles" and the "Elements" (great as they both were in their own day) to the luminous, lucid, and comprehensive arrangement of Geikie's splendid and systematic "Text-Book." The one is an agreeable and able dissertation on a number of isolated and floating geological facts; the other is a masterly and cosmically-minded account of the phenomena observable on the outer shell of a cooling world, duly considered in all their relations, and fully co-ordinated with all the chief results of all elder and younger sister sciences.

The battle of uniformitarianism itself, however, was but a passing episode in the great evolutionary movement. That movement began along several distinct lines toward the close of the previous century, and only at last consciously recognized its own informing unity of purpose some thirty-five years ago. From another point of view—in connection with its influence upon thought at large—the evolutionary crisis has been treated elsewhere in this review by a philosophic thinker; but in its purely scientific aspect it must also be briefly considered here, forming, as it does, the acknowledged mainspring of all living and active contemporary science.

Evolution is not synonymous with Darwinism. The whole immensely exceeds the part. Darwinism forms but a small chapter in the history of a far vaster and more comprehensive movement of the human mind. In its astronomical development evolution had already formulated itself with perfect distinctness before the period with which we have here especially to deal. The nebular theory of Kant and Laplace was the first attempt to withdraw the genesis of the cosmos from the vicious circle of metaphysical reasoning, and to account for it by the continuous action of physical and natural principles alone. Our own age has done much to cast doubt upon the unessential details of Kant's rough conception, but, in return, it has made clearer than ever the fundamental truth of its central idea—the idea that stars, and suns, and solar systems, consist of materials once more diffusely spread out through space and now aggregated around certain fixed and definite nuclei by the gravitative force inherent in their atoms and masses. As these masses or atoms drew closer together in union around the common center, their primitive potential energy of separation (frankly to employ the terminology of our own time) was changed, first into the kinetic energy of molar motion in the act of union, and then into the kinetic energy of molecular motion or heat, as they clashed with one another in bodily impact around the central core. Each star, thus produced, forever gathers in materials from its own outlying mass, or from meteoric bodies, upon its solidifying nucleus, and forever radiates off its store of associated energy to the hypothetical surrounding ether. The fullest expression of this profound cosmical conception has been given in our own time by Tait and Balfour Stewart, working in part upon the previous results of Kant. Laplace, the Herschels, Mayer, Joule, Clerk Maxwell, and Sir William Thomson. Deeply altered as the nebular hypothesis has been by the modern doctrine of correlation and conservation of energies, and by modern researches into the nature of comets, meteors, and the sun's envelopes, it still remains in its ultimate essence the original theory of Kant and Laplace.

Science has thus, within the period of our own half-century, exhibited to us the existing phase of the universe at large in the light of an episode in a single infinite and picturable drama, setting out long since from a definite beginning, and tending slowly to a definite end. Other phases, inconceivable to us, may or may not possibly have preceded it; yet others, equally inconceivable, may or may not possibly follow. But as realizable to ourselves, within our existing limitations, the physical universe now reveals itself as starting in a remote past from a diffuse and perhaps nebulous condition, in which all the matter, reduced to a state of extreme tenuity, occupied immeasurably wide areas of space, while all the energy existed only in the potential forms as separation of atoms or molecules; and the evidence leads us to look forward to a remote future when all the matter shall be aggregated into its narrowest possible limits, while all the energy, having assumed the kinetic mode, shall have been radiated off into the ethereal medium. Compared to the infinite cosmical vistas thus laid open before our dazzled eyes, all the other scientific expansions of our age shrink into relative narrowness and insignificance.

As in the cosmos so in the solar system itself, evolutionism has taught us to regard our sun, with its attendant planets and their ancillary satellites, all in their several orbits, as owing their shape, size, relations, and movements, not to external design and deliberate creation, but to the slow and regular working out of physical laws, in accordance with which each has assumed its existing weight, and bulk, and path, and position.

Geology here takes up the evolutionary parable, and, accepting on trust from astronomy the earth itself as a cooling spheroid of incandescent matter, it has traced out the various steps by which the crust assumed its present form, and the continents and oceans their present distribution. Lyell here set on foot the evolutionary impulse. The researches of Scrope, Judd, and others into volcanic and hypogene action, and the long observations of geologists everywhere on the effects of air, rain, ice, rivers, lakes, and oceans, have resulted in putting dynamical geology on a firm basis of ascertained fact. The heated interior has been shown almost with certainty to consist of a rigid and solid mass, incandescent, but reduced to solidity under the enormous pressure of superincumbent rocks and oceans. The age of the earth has been approximately measured, at least by plausible guess-work ; and the history of its component parts has been largely reconstructed. Structural and stratigraphical geology have reached a high pitch of accuracy. It is beginning to be possible, by convergence of evidences, as the American geologists have shown, and as Geikie has exemplified, to rewrite in part the history of continents and oceans, and to realize each great land-mass as an organic whole, gradually evolved in a definite direction and growing from age to age by regular accretions. Where the old school saw cataclysms and miracles, vast submergences and sudden elevations, the new school sees slow development and substantial continuity throughout enormous periods of similar activity.

It would be impossible to pass over in silence, in however brief a *résumé*, the special history of the glacial epoch theory—a theory referring indeed only to a single episode in the life of our planet, but fraught with such immense consequences to plants and animals, and to man in particular, that it rises into very high importance among the scientific discoveries of our own era. Demonstration of the fact that the recent period was preceded by a long reign of ice and snow, in the northern and southern hemispheres alike, we owe mainly to the fiery and magnetic genius of Agassiz ; and the proof that this glacial period had many phases of hotter and colder minor spells has been worked up in marvelous detail by James Geikie and other able coadjutors. Its theoretic explanation, its probable causes, and its alternation in the northern and southern hemispheres by turns, have been adequately set forth by Croll in a profoundly learned and plausible hypothesis. Upon the glacial epoch depend so many peculiarities in the distribution of plant and animal forms at the present day that it has come to assume a quite exceptional importance among late geological and biological theories. Standing at the very threshold of the recent period, the great ice age forms the fixed date from which everything in modern Europe and America begins—it is the real flood which stands to the true story of our continent and our race in the same relation as the Noachian deluge stood to the imagined or traditional world of our pre-scientific ancestors. Modern history begins with the glacial epoch.

The science of life has been even more profoundly affected by the evolutionary impulse than the concrete sciences of inorganic totals. In 1837 biology as such hardly existed ; zoölogy and botany, its separate components, were still almost wholly concerned with minute questions of classification ; "vital force" and other unimaginable metaphysical entities were the sole explanations currently offered of all the phenomena of plant and animal life. But Charles Darwin had then just returned from the cruise of the Beagle, and was revolving slowly in his own mind the observations and ideas which blossomed out at last into the "Origin of Species." The germs of evolutionism were already in the air. Lamarck's crude speculations had aroused the attention of all the best biological intellects of the era. Before long Chambers published the "Vestiges of Creation," and Herbert Spencer was hard at work upon the groundwork of the "System of Synthetic Philosophy." The paleontological work of Agassiz, Barraude, Owen, and others, and the general advance in knowledge of comparative anatomy and embryology, paved the way for the triumph of the new ideas; while simultaneously the dry bones of botany were being kindled into life by a younger school of workers in many French and German gardens and laboratories. With the appearance of the "Origin of Species" in 1859, the new departure definitely began. In twenty years the whole world was converted *en bloc*. Evolution on the organic side has been chiefly expounded in England by Darwin, Huxley, Spencer, and Wallace; and on the whole, though of worldwide acceptance, it has been a peculiarly English movement. Hitherto, indeed, we Britons have been remarkable as the propounders of the deepest and wisest scientific generalizations: it is only of late years that our bookish educators of the new school have conceived the noble ambition of turning us all into imitation Germans.

Life thus falls into its proper place in the scheme of things as due essentially to the secondary action of radiated solar energy, intercepted on the moist outer crust of a cooling and evolving planet. Its various forms have been gradually produced, mainly by the action of natural selection or survival of the fittest on the immense number of separate individuals ejected from time to time by pre-existing organisms. How the first organisms came to exist at all we can as yet only conjecture; to feeble and unimaginative minds the difficulty of such a conjecture seems grotesquely exaggerated; but granting the existence of a prime organism or group of organisms plus the fact of reproduction with heredity and variations, and the tendency of such reproduction to beget increase in a geometrical ratio, we can deduce from these simple elementary factors the necessary corollary of survival of the fittest, with all its far-reaching and marvelous implications. Our age has discovered for the first time the cumulative value of the infinitesimal. "Many a little makes a mickle"; that was Lyell's key in geology, that was Darwin's key in the science of life. Herbert Spencer's "Principles of Biology" most fully sum up this whole aspect of evolution as applied to the genesis of organic beings.

In 1837, the science of man, and the sciences that gather round the personality of man, had scarcely yet begun to be dreamed of. But evolutionism and geological investigation have revolutionized our conception of our own species and of the place which it holds in the hierarchy of the universe. At the very beginning of our fifty years, Boucher de Perthes was already enthusiastically engaged in grubbing among the drift of Abbeville for those rudely-chipped masses of raw flint which we now know as palæolithic hatchets. Lyell and others meanwhile were gradually extending their ideas of the age of our race on earth ; and accumulations of evidence, from bone-caves and loess, were forcing upon the minds of both antiquaries and geologists the fact that man, instead of dating back a mere trifle of six thousand years or so, was really contemporary with the mammoth, the cave-bear, and other extinct quaternary animals. The mass of proofs thus slowly gathered together in all parts of the world culminated at last in Lyell's epoch-making "Antiquity of Man," published three years after Darwin's "Origin of Species." Colenso's once famous work on the Pentateuch had already dealt a serious blow from the critical side at the authenticity and literal truth of the Mosaic cosmogony. It was the task of Lyell and his coadjutors, like Evans, Keller, and Christy and Lartet, to throw back the origin of our race from the narrow limits once assigned it into a dim past of immeasurable antiquity. Boyd Dawkins, James Geikie, Huxley, Lubbock, De Mortillet, and Bourgeois have aided in elucidating, confirming, and extending this view, which now ranks as a proved truth of paleontological and historical science.

Darwin's "Descent of Man," published some years later, was an equally epoch-making book. Lubbock's "Prehistoric Times," sent forth in 1865, and "Origin of Civilization," in 1870, had familiarized men's minds with the idea that man, instead of being "an archangel ruined," had really started from the savage condition, and had gradually raised himself to the higher levels of art and learning. Tylor's "Early History of Mankind," followed a little later by his still more important work on "Primitive Culture," struck the first note of the new revolution as applied to the genesis of religious concepts. McLennan's "Primitive Marriage" directed attention to the early nature and relations of the tribe and family. Wallace's essay on the "Origin of Human Races," and Huxley's valuable work on "Man's Place in Nature," helped forward the tide of naturalistic explanation. And by the time that Darwin published his judicial summing up on the entire question of man's origin, the jury of scientific opinion throughout the world had pretty well considered its verdict on all the chief questions at issue.

The impetus thus given to the sciences which specially deal with man, has been simply incalculable. Philology has been revolutionized. Language has told us a new story. Words, like fossils, have been made to yield up their implicit secrets. Prehistoric archæology has assumed a fresh and unexpected importance. The history of our race, ever since tertiary times, and throughout the long secular winters of the glacial epoch, has been reconstructed for us from drift and bone-cave, from barrow and picture-writing, with singular ingenuity. Anthropology and sociology have acquired the rank of distinct sciences. The study of institutions has reached a sudden development under the hands of Spencer, Tylor, McLennan, Maine, Freeman, Lang, and Bagehot. Comparative mythology and folk-lore have asserted their right to a full hearing. Evolutionism has penetrated all the studies which bear upon the divisions of human life. Language, ethnography, history, law, ethics, and politics, have all felt the widening wave of its influence. The idea of development and affiliation has been applied to speech, to writing, to arts, to literature, nay, even to such a detail as numismatics. Our entire view of man and his nature has been reversed, and a totally fresh meaning has been given to the study of savage manners, arts, and ideas, as well as to the results of antiquarian and archæological inquiry.

In psychology, the evolutionary impulse has mainly manifested itself in Herbert Spencer, and to a less degree in Bain, Sully, Romanes, Croom Robertson, and others of their school. The development of mind in man and animal has been traced *pari passu* with the development of the material organism. Instinct has been clearly separated from reason: the working of intelligence and of moral feeling has been recognized in horse and dog, in elephant and parrot, in bee and ant, in snail and spider. The genesis and differentiation of nervous systems have been fully worked out. Here Maudsley has carried the practical implications of the new psychology into the domain of mental pathology, and Ferrier has thrown a first ray of light upon the specific functions of portions of the brain. Galton's "Hereditary Genius" and other works have also profoundly influenced the thought of the epoch: while Bastian, Clifford, Jevons, and others have carried the same impulse with marked success into allied lines of psychological research.

But the evolutionary movement as a whole sums itself up most fully of all in the person and writings of Herbert Spencer, whose active life almost exactly covers and coincides with our half-century. It is to him that we owe the word evolution itself, and the general concept of evolution as a single, all-pervading natural process. He, too, has traced it out alone through all its modes, from sun and star, to plant and animal and human product. In his "First Principles," he has developed the system in its widest and most abstract general aspects; in the "Principles of Biology," he has applied it to organic life; in the "Principles of Psychology," to mind and habit; in the "Principles of Sociology," to societies, to politics, to religion, and to human activities and products generally. In Spencer, evolutionism finds its personal avatar: he has been at once its prophet, its priest, its architect, and its builder.

Second only in importance to the evolutionary movement among the scientific advances of our own day must be reckoned the establishment of that profound fundamental physical principle, the conservation of energy. Even before the beginning of our half-century, Davy and Rumford (especially the latter) had caught faint glimpses of the coming truth in this direction. They recognized that heat was a mode of motion, and Rumford went so far as to observe that the energy generated by a given amount of hay burned in an engine might be measured against the energy generated by the same amount of hay consumed by horses. But to Dr. Joule, of Manchester, in our own time, is due the first great onward movement, in the discovery and determination of the mechanical equivalent of heat. Joule's numerous experiments on the exact relation between heat and mechanical energy resulted in the establishment of a formula of equivalence in terms of kilogrammetres necessary to raise by one degree centigrade the temperature of one kilogramme of water. More properly put, he showed that the energy required to raise a weight of one hundred pounds through one foot was equivalent to the amount required to raise a certain fixed quantity of water through one degree in temperature.

Starting from this settled point, it soon became clear to physical thinkers that every species of energy was more or less readily convertible into every other, and that an exact numerical equivalence existed between them. This principle, which first clearly emerged into the consciousness of physicists about the middle decades of the present century, was originally known under the name of "Persistence of Force," in which form Grove's well-known little treatise helped largely to popularize its acceptance. But, as time went on, the underlying distinction between force and energy came to be more definitely realized, and the phrase conservation of energy began to supersede the older and erroneous terminology. The realization of the varying nature of energy as potential and kinetic helped in the transformation of the prime concept. At last, under the hands of Clausius, Helmholtz, Mayer, Clerk Maxwell, Tait, and Balfour Stewart, the doctrine assumed its modern form—that all energies are mutually convertible, and that the sum-total of energy, potential and kinetic, is a constant quantity throughout the cosmos.

The practical applications of the doctrine of energy are as yet only in their infancy. The whole mass of theoretical science has to be re-written in accordance with this new and fundamental law. The whole field of applied science has to be developed and enlarged by the light of this pregnant and universal principle. Its implications are all-pervading. In astronomy it has profoundly affected all our conceptions as to the sun's heat, the orbits of planets, the nature of meteors, the past, present, and future of the universe. In biology it has taught us to envisage the plant mainly as a machine in which kinetic energy is being transformed into potential; the animal mainly as a machine in which potential energy is being transformed back again into kinetic. In mechanics and the mechanical arts it has produced and is producing immense changes. And in the future it is destined still more profoundly to alter our mechanical ideas and activities: the great revolution there is only just beginning; another half-century is yet needed fully to develop it.

These two great principles—evolution and the conservation of energy—form the main bulk of our age's addition to the world's accumulated stock of knowledge. But among the separate sciences many wonderful advances have also been made which can not be overlooked in the briefest retrospect of the half-century's gains. To these a few words must next be devoted.

Among sciences of the abstract-concrete group, electricity had hardly got beyond the stage of an elegant amusement at the opening of our epoch. Statical electricity was still the department about which most was known. Galvanism as yet stood apart as a distinct study. Its connection with magnetism had not long been proved by the discoveries of Oersted. In 1837 itself, however, Wheatstone constructed the first telegraph. From that moment, under the fostering care of Faraday, Daniell, Cooke, Morse, Arago, Tyndall, Edison, and Thomson, electric science became a power in the world. The whole theory of electricity as a mode of energy has since been fully explored and expounded. A vast field has been added to science. Units and modes of absolute measurement have been invented. The telephone and microphone have been introduced; secondary batteries have been formed and improved; the dynamo has become a common object of the country; and the electric light has grown under our very eyes into a practical and extremely dazzling reality. Electricity, as we know it, with all its manifold useful applications, is almost entirely a creation of the last half-century.

In physics the present epoch, though chiefly remarkable for the series of investigations which led up to the discovery of the law of conservation, has also illustrated many minor principles of the first importance. The true theory of heat and the laws of radiant energy have been definitely formulated. The undulatory theory of light—a discovery of the previous quarter-century — has been universally adopted and justified. Thermo-dynamics have been elevated into a great and increasing branch of science. Sir William Thomson's law of dissipation of energy has completed and rounded off the theory of conservation. The causes and methods of glacier-motion have been investigated and established. Photography has almost passed through its entire life-cycle. The polarization of light has been observed and studied. Spectrum analysis has come into the front rank as an instrument of research. In short, a greater number of new physical phenomena have been discovered or old ones interpreted than in the whole space of previous time put together.

In chemistry, the advance has been more in detail than elsewhere. Chemical science alone still remains a somewhat fragmentary mass of individual facts and observations, colligated by minor laws and analogies, but unilluminated as yet by the broad light of any great and all-embracing general principles. Since Dalton's atomic theory, indeed, no philosophic generalization of the very first magnitude has been introduced into chemistry. But generalizations of the second order—vastly interesting to chemists, and to chemists alone—have been made in such numbers as to defy enumeration; wider conceptions have in many ways sprung up; the science has assumed a new form; and some of the results of spectrum analysis and of the new chemistry lead to the hope that this science too is on the eve of arriving at that stage of far-reaching fundamental truths, which it is the special function of our generation to bring about.

Mathematics has also undergone a new development, scarcely capable of being rendered comprehensible to the lay intelligence.

The applications of physical, electrical, and chemical science in the great mechanical and industrial inventions of our iron age, belong elsewhere, and are already familiar in many respects to all of us. Railways slightly antedate the epoch; the telegraph is just coeval with it. The first submarine cable was in 1851, the first transatlantic in 1866. Electro-plating, the steam-hammer, the Armstrong gun, the Bessemer process, must not be forgotten. Other triumphs of applied science fall more fitly under another heading.

Among the concrete sciences, astronomy has made vast advances during the past half-century. Lord Rosse's great telescope was set up at Parsonstown in 1844. Two years later, Leverrier and Adams made their curious simultaneous discovery of the planet Neptune. But it is not so much in new lists of suns or satellites—though the name of these alone has, indeed, been legion—as in the fresh light cast upon the nature and constitution of older ones, that our age has been most singularly successful. The invention of the spectroscope, and the rapid development of spectrum analysis, have placed in the hands of astronomers a method and an instrument inferior in value only to the telescope itself. It is not so long since Comte dogmatically declared we could never know anything of the chemical composition of the fixed stars. Scarcely were the words well out of his mouth when the invention of the spectroscope and its application to the spectra of incandescent bodies brought the investigation of the elements in the sun and stars well within the reach of human possibility. The successive researches of Wheatstone, Foucault, Secchi, Bunsen, Kirchhoff, and Norman Lockyer, exactly covering our fifty years, have at last enabled us to prove almost with certainty the presence in the solar envelopes of several metals already known in the earth's crust, such as potassium, sodium, calcium, iron, nickel, and chromium. So delicate is the spectroscopic test, that it renders possible the detection of so small a fraction as $\frac{1}{200,000,000}$ part of a grain of sodium. And by revealing bright lines in the spectrum not previously referable to any known body, it has been the means of discovering five new metals: cæsium and rubidium (detected by Bunsen), thallium (by Crookes), indium (by Richter), and gallium (by Lecoq).

Our knowledge of the sun's constitution, in particular, has advanced with extraordinary rapidity during the period here under review. Even thirty years ago we knew little of the central orb of our system save a few naked mathematical facts as to his diameter, his density, his attractive power, and the spots on his surface. Thirty years of constant investigation have now enabled us to picture to ourselves, with tolerable accuracy, the actual state of the sun's fiery exterior. The new era began with Schwabe's discovery of the periodicity of the sun's spots in 1851. The development of spectroscopic analysis between 1854 and 1870 followed hard on this first impulse. Since 1860 eclipses have yielded us valuable results. Observations on transits of Venus have largely corrected a serious error in our calculations of our primary's distance from the earth. Janssen and Lockyer have taught us how to observe at any time, by means of the spectroscope, phenomena which were previously observable only during moments of total eclipse. Huggins has shown us how to isolate those marvelous protuberances of incandescent gas which burst forth with explosive violence from time to time from the edge of the photosphere. Tacchini, Secchi, Young, and others have carried out these interesting researches to a still higher pitch of certainty and accuracy; and the sun's geography, so to speak, is to-day no longer a closed book to mundane observers. We know our central luminary now as a mass of intensely heated gas, surrounded by a shell of luminous cloud, the photosphere, formed by the cooling of condensable vapors at the surface where exposed to the cold of outer space; and floating in a chromosphere of incondensable gases (notably hydrogen) left behind by the formation of the photospheric clouds. The mysterious corona alone as yet evades our methods of research.

In the solar system at large, great advances have been made in the details of planetary astronomy. The differences in kind between the older group of interior planets, now in their cold and solid age, and the younger group of exterior planets, still in their boisterous and fiery youth, have been well ascertained. This truth—of so much interest from the evolutionary point of view—has been especially worked out by R. A. Proctor. Nasmyth's observations on our own dead satellite, the moon, have given us a graphic and appalling picture of a worn-out world in its last stage of lifeless, waterless, and airless decrepitude. New moons have been added to Mars, and several tedious additions have been made by minutely obstetrical astronomers to the already inconveniently large family of the minor planets. All our fresh knowledge of Jupiter and Saturn, those turbulent and volcanic orbs, has helped to impress the general soundness of the evolutionary hypothesis; while the increasingly important study of meteors and comets has brought us close to the very threshold of the great ultimate mystery of star-genesis and world-forming. The extreme tenuity of the mass of comets, the inconceivable rarity of the matter composing their gaseous tails, the curious phenomena of the instantaneous reversal on passing their perihelion, the proof that their light is partly reflected and partly direct, the spectroscopic determination of their composition, the discovery of the essentially planetary nature of meteor-streams, and the recognition of their vast numbers swarming through space, are among the most striking novelties of the last half-century in this direction.

In sidereal astronomy, besides the mere mechanical increase of mapping, the chief advances have been made in observations upon double stars, spectroscopic analysis of fixed stars and of nebulæ, and consequent proof of the fact that truly irresolvable nebulæ do really exist, the gaseous raw material of future stars and solar systems. It must be added that within the half-century the hypothetical ether has amply vindicated its novel claim to take its place as a mysterious entity side by side with matter and energy among the ultimate components of the objective universe.

In geology, the chief theoretical advances have been made by the recognition of the cosmical aspects of the earth's history; its relations to nebula, sun, and meteor; the importance of eccentricity and precession of the equinoxes, and the possible results of ancient changes in its rates of motion, tides, and so forth. Dynamical geology has made vast strides, especially in the investigation of volcanic phenomena, mountain-building, and the birth and growth of islands and continents. The science of earth-sculpture has been developed from the very beginning. Stratigraphical geology has been largely improved. And in paleontology an immense number of the most striking and interesting of fossil forms have been brought to light. Among them may be specially mentioned those which have proved of critical importance as evidences of the truth of organic evolution—the toothed birds of the Western American cretaceous deposits, the lizard-like bird or bird-like feathered lizard of the Solenhofen slates, Marsh's remarkable series of ancestral horses, Cope's beautiful reconstruction of the fossil progenitors of existing camels. Monkeys certainly, anthropoid apes clearly, man doubtfully, have been detected in the fossil state. India, Australia, Canada, the United States have been explored and surveyed, geologically and paleontologically; and the exploitation of the far West in particular has not only added immensely to our knowledge of life in past times, but has also revolutionized our conceptions as to the gradual growth and development of continental areas, and the occasional vast scale of volcanic phenomena. The permanence of all great continents and oceans is now a proved truth of geology. It has been re-enforced and extended from a totally different point of view by Alfred Russel Wallace, whose masterly works on the "Geographical Distribution of Animals," and on "Island Life," have immense geological as well as biological implications.

In pure biology, besides the grand advance implied in the establishment of the doctrine of descent with modification, and its subsidiary principles of survival of the fittest and sexual selection, profoundly important minor results have also been attained in many directions. Embryology in the hands of Von Baer and his successors, notably Kowalevsky and Balfour, has acquired prime importance as an instrument of geological research. Comparative osteology in the hands of Owen, Huxley, Gaudry, and Busk has given us new views of the relationships between vertebrate animals. The pedigree of fishes, amphibians, reptiles, birds, and mammals has been worked out with a considerable degree of fullness from the hints supplied us by the amphioxus, the ascidian larva, the facts of embryology, and the numerous recent discoveries of intermediate or arrested organisms, recent and extinct. Invertebrate zoölogy has been rescued from chaos and partially reduced to temporary and uncertain order. Botany, at once the dullest and the most alluring of all sciences, has been redeemed from the vicious circle of mere classificatory schemes, and vivified by the fresh and quickening breath of the evolutionary spirit. The new morphology has revolutionized our ideas of vegetal homologies; the new physiology has fastened all its attention on the adaptations of the plant to its natural environment. The fascinating study of the mutual relations between flower and insect in particular, set on foot before the dawn of our epoch by Christian Sprengel, but reintroduced to notice in recent times by Darwin's works on orchids and on cross-fertilization, has been followed out with ardor to marvelous results by Hermann Müller, Axel, Delpino, Hildebrand, Lubbock, Ogle, and others. Heer and Saporta have worked out in great detail the development of several fossil floras. Last of all, Herbert Spencer has cast the dry light of his great organizing and generalizing intelligence on the problems of heredity, genesis, variation, individuality, and the laws of multiplication. Fifty years ago biology was a mighty maze wholly without a plan. To-day the clew has been found to all its main avenues, and even the keys of its minor recesses are for the most part well within reach of the enlightened observer.

Even the actual gains in the number of new organisms added to our lists during the last half-century are in themselves astonishing; and, strange to say, the species that bear most closely upon the theory of organic evolution are almost all of them quite recent additions to our stock of knowledge. The gorilla appeared on the scene at the critical moment for the "Descent of Man." Just on the stroke when they were most needed, connecting links, both fossil and living, turned up in abundance between fish and amphibians, amphibians and reptiles, reptiles and birds, birds and mammals, and all of these together in a perfect network of curious cross-relationships. Lizards that were almost crows, marsupials that were almost ostriches, insectivores that were almost bats, rodents that were almost monkeys, have come at the very nick of time to prove the truth of descent with modification. Among the most interesting of these strange coincidences are such episodes as the discovery in the rivers of Queensland of that strange lung-bearing and gill-breathing fish, the barramunda, only known before in the fossil form as a long-extinct species, but in whose anatomical structure Günther has discerned the missing link between the antique ganoid type of fishes on the one hand, and the mud-fish and salamandroid amphibians on the other.

In the practical applications of biological and physiological science to the wants and diseases of human life two at least deserve mention here. Anæsthetics are almost entirely a growth of our half-century: chloroform was first employed in operations by Simpson in 1847, and the use of other similar agents is still more recent. Again, the discovery that zymotic diseases in men and animals are due to the multiplication within the body of very minute organisms, known as microbes, bacteria, or bacilli, now promises to revolutionize medical science. Their connection with decomposition was still earlier detected. The names of Pasteur, Tyndall, and Koch are specially identified with researches into the nature of these tiny morbid organisms and the best means of preventing or neutralizing their attacks, either on living or dead matter.

In marvelous contrast to the fragmentary and disjunctive science of fifty years ago, modern science at the present day offers us the spectacle of a simple, unified, and comprehensible cosmos, consisting everywhere of the same prime elements, drawn together everywhere by the same great forces, animated everywhere by the same constant and indestructible energies, evolving everywhere along the same lines in accordance with the self-same underlying principles. It shows us the community of ultimate material in sun and star, in nebula and meteor, in earth and air and planet and comet. It shows us identical metals and gases in fiery photosphere and in electrically-heated matter in our own laboratories. It shows us atoms of hydrogen or of sodium pulsating rhythmically with like oscillations in star-cloud or sun-cloud, and in London or Berlin. It exhibits to our eyes or to our scientific imagination a picture of the universe as a single whole, a picture of its evolution as a continuous process—one type of matter diffused throughout space; one gravitative attraction binding it together firmly in all parts; one multiform energy quivering through its molecules or traversing its ether, in many disguises of light, and heat, and sound, and electricity. It unfolds for us in vague hints the past of the universe as a diffuse mass of homogeneous matter, rolling in upon its local centers by gravitative force, and yielding up its primitive energy of separation as light and heat to the ethereal medium.

It suggests to us this primitive energy of separation as the probable source of such light and heat in suns and stars as we now know them. It posits for us our own planet as an orb gathered in from the original cloud-mass, with outer surface cooled and corrugated, and with two great envelopes, atmospheric and oceanic, gaseous and liquid, still floating or precipitated around its denser core. It teaches us how the hard crust of the hot central mass has been uplifted here into elevated table-land or depressed there into hollow ocean-bed. By the aid of its newest instrument, meteorology, it lets us see how incident solar energy, raising clouds and causing rainfall, with its attendant phenomena of drainage and rivers, has carved and denuded the upheaved masses into infinite variety of hill and valley. It shows us how sediment, thus gathered by streams on the bed of the sea, is pushed up once more by volcanic power or lateral pressure into Alpine chains and massive continents, and how these in their turn have been worn down by the long-continued bombardment of aqueous or aërial action into mere stumps or relics of their primitive magnitude. It puts before us life as an ultimate result of solar energy falling on the watery and gaseous shell of such a solidified planet. It suggests to us how light, acting chemically on the leaves or fronds or cells of the green herb, stores up in them carbohydrates, rich in potential energy, which animals afterward use up as food, or man utilizes as coal in his grates and his locomotives. It exhibits to us the animal organism as essentially a food-engine in whose recesses solar energy, stored as potential by the plant, is once more let loose by slow combustion in the kinetic form as heat and motion. It enables us to regard the body as a machine in which stomach and lungs stand for furnace and boiler, the muscles for cylinder, piston, and wheels, and the nervous system for an automatic valve-gear. It traces for us from small beginnings the gradual growth of limb and organ, of flower, fruit, and seed, of sense and intellect. With the simple key of survival of the fittest it unlocks for us the secret of organic diversity and universal adaptation. It reconstructs for us from obscure half-hints the origin of man; the earliest stages of human history; the rise of speech, of arts, of societies, of religion. It unifies and organizes all our concepts of the whole consistent system of Nature, and sets before our eyes the comprehensive and glorious idea of a cosmos which is one and the same throughout, in sun and star and world and atom, in light and heat and life and mechanism, in herb and tree and man and animal, in body, soul, and spirit, mind and matter. Almost all that is most vital and essential in this conception of our illimitable dwelling-place, the last half-century has built up for us unaided.—*Fortnightly Review.*

# THE METAL ART OF ANCIENT MEXICO.

By HENRY L. REYNOLDS, Jr.

Of the contemporary writers of the conquest of ancient Mexico there are but three who have told us that there were in that city not only objects of gold, silver, and copper, but also some of bronze and tin. They have, moreover, told us that some of these metals were most skillfully wrought, and that the designs fashioned therefrom were so marvelous and beautiful that even the European goldsmiths of those days could not excel them.

However true this may be, it should be remarked that there is neither in the museums of this country, Spain, nor Mexico a single representative relic of this advanced skill in metal-working. All the Mexican specimens of unquestionable pre-Columbian origin that we have are of pure copper, and are simply hammered into shape. There are a few of bronze, but these, as well as some of copper, can not be said to antedate the conquest.

M. Guillaume Dupaix, who was employed by the King of Spain in 1805 to explore Mexico in search of remains of Aztec art, is the first to tell us anything about Mexican metal relics. Though an endeavor is evident throughout his notes to strengthen the belief in the greatness of Aztec civilization, the only metal specimens that he describes are three of what he calls "red copper." His annotator, Lenoir, referring to these metal specimens, properly adds that "this red copper is native, whereas the yellow copper is the result of *an alloy which the Mexicans, it appears, did not use.*" *

The twelve Mexican axes collected by Dr. Palmer, Mr. Frederick Ober, Professor Agassiz, and Mr. L. H. Ayme, seven of which are in the Peabody Museum at Cambridge, and the two in the National Museum at Washington, are all of pure copper; and Professor F. W. Putnam, who had the privilege of examining the former, tells us that there is no doubt that they were all shaped by hammering. This is also true of those in the National Museum.

These axes are of but two types, and it is gratifying to see that they correspond to the two forms figured in the ancient paintings. We might, therefore, reasonably deduce from this the fact that those figured axes were of a like composition to these that survive, and also that they were wrought with the hammer. To further sustain this conclusion, Landa gives, in his "Cosas de Yucatan," a cut of a Yucatan axe which also corresponds in shape to those just mentioned. These, he says, "are made of a certain metal, and shaped by hammering the edge with stones." Now, upon the authority of Cogolludo,† we know that these hammered axes of Yucatan were made in Mexico, and

* "Antiquités Mexicaines," deuxième partie, Planche II.

† "Historia de Yucatan," lib. iv, cap. iii.

brought from that country to be exchanged for other merchandise, and that they were made of copper.

All those very uniform implements, termed "T-shaped," of which we know, are also of pure or unalloyed copper. As to these, however, there is nothing in the records or in the objects themselves to warrant belief in their ante-Cortesian origin. The material of which they are made appears to be the hammered sheet-copper in use before the invention of the rolling-mill in 1784, and which formed, as the records show, a very favorite article of aboriginal trade. The specimens bear no evidence of oxidation to indicate great age, and the fact that their edges are very neatly cut gives rise to the suspicion that their manufacture must have been subsequent to the introduction of the necessary European cutting-tools. They were found only in the State of Oaxaca, and in each find there were great numbers of them. It is not improbable, then, that for some purpose or other a large lot of sheet-copper was at an early day introduced among the natives of that section, who in turn converted it into these implements. What special use they were intended to serve we can at present only surmise. The absence of objects like these in the aboriginal codices should be noted, while throughout the whole literature of the conquest there is but one approach to their description. This is found in Torquemada, who says: "They also used certain copper coins almost in the shape of a Greek Tau, its width about three or four fingers. It was a thin piece of plate of an uncertain size, and contained much gold." It is not likely that the specimens in question were used as coins, for the edges of what might be called the shank are flattened as if for the attachment of a handle, and hence its probable use as an implement. Moreover, they do not answer to Torquemada's description, for, instead of being three or four fingers in width, they vary in this respect from fourteen to twenty centimetres; and, instead of containing much gold, analyses have proved them to be of very pure copper. Admitting them, however, to be the objects that Torquemada had in mind when he wrote, he is not sufficient authority for ascribing them to pre-Cortesian art.

In the National Museum at Washington there are three copper specimens that were used as awls. One of them, which is nine inches long, is pointed at one end, and flattened or beveled at the other, while it bears unmistakable evidences of having been shaped by hammering. It closely resembles in form, composition, and fabrication a similar tool lately procured by the Bureau of Ethnology from a mound in Wisconsin. These, with other specimens, were purchased from the collection of the distinguished Mexican archæologist, Don Fernando Ramirez, but it is to be deeply regretted that, with the exception of one or two specimens, no data accompanied them as to the locality or manner in which they were found. We can not even say with certainty that they were found within the limits of Mexico.

In this collection came also five specimens the precise use of which we do not know. They also are of copper, but a close examination shows them to be unmistakably of drawn wire, the manufacture of which it is not pretended the pre-Columbian native knew. These specimens consist each of a single piece of wire, averaging four inches in length, and are flattened or beveled at both ends.

Besides the above specimens, this collection comprises two needles of copper, two objects of twisted copper wire, nine little bells, and two bronze chisels.

The two needles, like the specimens last described, are of drawn copper wire, and are so called because in one end there is an eye, while the other is slightly pointed.

The two twisted wire specimens consist of four pieces of very fine copper wire, six inches long, and neatly twisted about one another. The purpose they served is a matter of speculation.

Four of the little bells in this collection appear to be alloyed, but are we warranted, in the absence of knowledge as to where and how they were obtained, in ascribing them to pre-Cortesian art? They bear no evidences of oxidation to indicate great age, and I am disposed to regard them as the bells of which Sahagun speaks in the following quotation: "The goldsmith is an expert in the selection of good metal. He knows how to make of it whatever he likes, and does it with skill and elegance. He is conversant with all kinds of devices, and all this he does with composure and accuracy. He knows how to purify the ore and make plates of silver as well as of gold from the cast metal. He knows likewise how to make *molds of carbon*, and how to put the metal into the fire in order to smelt it." Farther on he says: "He who is a trader in needles casts, cleans, and polishes them well; he makes also bells, filters, punches, nails, axes, hatchets, coopers' adzes, and chisels." *

No one will pretend that Sahagun here refers to the metal-smiths as they worked before the conquest. For thirty years he lived among the surviving natives, to study their language and record all that he could concerning their customs, mythology, and arts. He gives, whenever it is obtained, all hearsay testimony as to the civilization which the Spaniards destroyed, but the bulk of his work, excepting the twelfth book, which is devoted to a history of the conquest, is the result of a study of the natives as he found them. This is evident in this case from the fact that he enumerates molds of carbon, needles, filters, coopers' adzes, hatchets, and nails, none of which are mentioned by the chroniclers of the conquest. Dr. Philipp Valentini, commenting upon this quotation, says, "A few new features are cropping out in this enumeration of implements, which give rise to the suspicion that the goldsmith is described, not as he worked before the year 1521, but as he had perfected himself and enlarged his technical knowledge through the intervention of Spanish mechanics in the year

* "Historia de la Nueva España," lib. x, cap. vii.

of Sahagun's writing, about 1550." These metal-smiths were evidently bound to secrecy in their art, for, in the Viceroy Mendoza's time, Lorenzana says that one of these workmen was imprisoned for counterfeiting the Spanish coins, and, though he was promised pardon if he would reveal the workshops of his people, his persistent silence caused him to be put to death.

We find that chisels also are enumerated by Sahagun in the above quotation, and there is no reason why we can not ascribe the three bronze chisels that we have to the native metal-smiths to whom he refers. We have, at any rate, no evidence, historic or archæologic, by which we might reasonably consider them as belonging to the period before the conquest. Two of these bronze chisels are in the National Museum at Washington, but, unfortunately for our present investigation, their origin is unknown, and no analysis of them has been made to determine the relative percentage of copper and tin.

The remaining bronze chisel is in the Museum of Mexico, and is described and figured in the annals of that institution, Vol. I, page 117. It should be noted that its form is very unlike either of the two to which we have above referred, and that it has a percentage of 97·87 parts of copper and 2·13 of tin, which is precisely the same as that of a bronze chisel found by Mr. J. H. Blake in Peru and described in Wilson's "Prehistoric Man," Vol. I, page 293. We know not where, when, or how it was found, and if we doubt that it was fashioned by the native metal-smiths who worked after the advent of the Spaniards, we might suppose it to have wandered thus far from its Peruvian home, for greater distances, we know, did the copper of Lake Superior travel in aboriginal barter.

But besides these there have also been found many other chisels, and these as far as we know are all of copper. Dupaix describes several which were plowed up in the neighborhood of the village of Antequera in Oaxaca. They are composed, he says, of red copper which we remember his editor, Lenoir, called native. Dr. Philipp Valentini refers to another which, he says, is similar in form and composition to those described by Dupaix. This was plowed up by Señor Andrez Axnar Perez on his plantation near the river Zompan in Tabasco, at a depth of nearly twelve inches. Unfortunately, none of Dupaix's chisels can now be found, but the cut he gives shows them to have been of the simplest form, and not unlike those in use by our carpenters to-day. These, and that of Señor Perez, are uniform in shape and composition, while each of the three of bronze presents a strikingly odd and distinct type. An analysis of their composition would doubtless show also a varying percentage of copper and tin, and we feel tempted, under the circumstances, to regard those of pure copper, which are uniform, as indigenous, and the bronze, which are odd, as importations from South America, or else the product of post-Columbian skill.

Thus we see that, excepting three chisels and four bronze bells, the specimens are all of pure copper, and, whether or not this pure copper is native, chemical experiments have not yet been able to determine. The fact that drawn wire is catalogued with the bronze specimens as Mexican antiquities bids us receive them with caution; and in this connection we must remember what Sahagun and Lorenzana have told us, that the Mexicans after the conquest, like the Navajos to-day, utilized some of the arts of the European, and worked largely and skillfully in metals. We must remember, also, that there has never been in Mexico, as in Peru and Wisconsin, a discovery of an ancient mine, neither a crucible nor any kind of tool by which the metal was extracted from the ore, yet investigations have been going on very actively in Mexico for nearly a century and a half.

We have, then, nothing whatever, so far as archæologic evidence goes, to show that the Mexicans acquired and practiced the art of smelting, refining, and alloying before the advent of the Spaniard.

Turning from this fact to an examination of the early historic records, we learn that Cortes, Gomora, and Bernal Diaz are the only original authorities whose statements imply a knowledge of smelting. But the honesty and accuracy of these very writers have been questioned. Though founded, to be sure, upon a more or less substantial basis of fact, their descriptions of Mexican civilization are palpably colored and idealized. The natural features of the country refute many of their statements, while others are characterized by gross discrepancy. They have been regarded, therefore, for the most part, as imaginary and delusive, and, since they are the main basis upon which rests the popular idea of a high civilization in ancient Mexico, that civilization has been thought fictitious in some of its most essential features, and in general greatly overdrawn.

Examining first the accounts of the expeditions that touched upon the shores of Yucatan and Central America prior to 1519, we find no mention of any metals except pure copper and gold. But Cortes, on the other hand, in one of his letters to the emperor, says that he saw within the market-place of Mexico "trinkets of gold and silver, of lead, bronze, copper, and tin." I can not agree with many writers in thinking that the gold which Cortes saw was the product of so enlightened and difficult an art as smelting. Though gold in the ore is rich and plentiful in the Mexican country, the inhabitants could not have been aware of any better method of obtaining it than by sifting it from river sands. Notwithstanding his numerous observations of marvelously wrought gold objects in Mexico, Bernal Diaz's own words should establish this fact. Montezuma, he says, informed them that their gold "was obtained from the province of Zacatula, where the earth which contained it was washed in wooden vessels, and the gold-dust sank to the bottom." It was also to be had, he says, in Tustepec, "where it was collected from the beds of rivers." Again, speaking of the expeditions sent out by Cortes in search of mines, he says that Gonzalo de Umbria, who went to Zacatula, reported that there "the natives washed gold out of the sand in small troughs."

If this were the only means employed, it is improbable that the Spaniards saw it in all the instances and in the great quantity that Cortez and Bernal Diaz describe; and that their statements in this regard are grossly exaggerated is evident from the fact that, with the exception of a few small trinkets, not a relic of the beautiful things of which they speak remains. Neither do the chronicles record a very great amount actually gathered by the rapacious conqueror, yet all the schemes which his mind could conceive must have been directed to this one object, not for personal greed only, but to meet the expectations of the emperor, to whom, when he had feared that he was to be deprived of his command, he had promised wealth and treasure. Though torture of the most barbaric description was employed to induce the natives to reveal the riches that they were supposed to hide, no more were obtained; and, in order that the Spanish king and those about his court may afterward understand the absence of the treasure in the kind and quantity which he had led them to expect, Cortes cautiously wrote that it was all lost in that disastrous revolution which first drove him from the city.

It is not to be supposed either that the half-civilized Aztec was aware of those many complex chemical processes by which silver is separated from the ore. If we are to credit him with this, we must call him a great metallurgist indeed, skilled in an art known even now only to a few, and which demands all the machinery and scientific accomplishments of our modern times. We know to-day that Mexico is richer in silver than any other country in the world, yet the mention of this metal in the records is noticeably infrequent, and it is especially significant that it does not figure in the articles of tribute. Let us, nevertheless, believe the exaggerating Gomora, and we find that all the silver actually collected by the Spaniards was only five hundred marks. These facts can not be reconciled with a knowledge of smelting. The little silver they may have had was doubtless only the native metal which is to be found in Mexico, or that which was obtained like the gold from the placer-washings.

Bronze, too, is in Cortes's list of metals, and if we accept bronze we must also accept tin, its necessary component. Though Cortes tells us that he saw tin in the market-place of Mexico, we find him shortly afterward deploring its absence when he desires to cast some cannon. He does not ask the natives to show him whence the tin of the market-place was obtained, but sends only his own men "*searching in all directions*," until it was at last found in the form of coins among the natives of Tasco. Then, inconsistent with his past conduct, he does not rob the natives of this very coveted metal, though his "distress for it had reached its highest point," but he sends his Spaniards, unassisted by natives, "*with the necessary tools* to bring him samples of it." After this a sufficient quantity is procured, though it cost him, he says, "*a work of much labor.*"

But, however much this may indicate the possession of tin among the natives, we know to-day that there is none in Tasco; and though, perhaps, it may be found in Michoacan and Jalisco, the Mexicans have not thought it worth their while to work it. Baron Humboldt, who paid a visit to Tasco, had perhaps the best opportunities for the discovery of a mine, but nowhere does he speak of finding any traces of such ancient works. Though he must have known what Cortes had said concerning Tasco, he tells us that there the natives obtained not tin, but silver. This tin of Tasco, it should be noted, is not mentioned by Bernal Diaz or Gomora, and this, with the tin seen on sale in the Mexican market, both vague and barren of description as to how it was obtained, are the only instances in the authorities upon which our belief is based. Tin, strange to say, is not embraced in that well-known list of tributes which were paid to Montezuma by the subordinate tribes, neither can it claim the distinction accorded to copper and gold to be figured in the ancient paintings. The axes figured therein, we have heretofore seen, could scarcely have been an alloy of copper and tin, for their shape corresponds to the axes in our museums, which are of hammered pure copper.

Our belief, then, in what Cortes has said concerning this metal is somewhat shaken, but additional reason for discrediting him will be hereinafter presented when we come to consider the circumstances that influenced his statements.

The fact that lead is also enumerated is enough to warn us to take these statements *cum grano salis.* I know of no place in Mexico where lead is worked to-day, though Humboldt tells us that in 1803 it was feebly mined in the extreme northeast. It is found to a limited extent in the States of Oaxaca and Chihuahua, but it is associated with silver; and, if the natives made use of this supply, which is extremely doubtful, they must have possessed the scientific knowledge by means of which the two metals are separated. Cortes is sustained in this statement as to lead only by Gomora; and he, while designedly reasserting what his master and patron had already said about the metals of the market-place, is careful, however, to add the important qualification that "lead was scarce."

The subordinate Cortes, on landing in Mexico, shrewdly saw in its conquest an opportunity for his ambition. He feared that he might in this be superseded by another should he await the forms of Spanish law, so he contrived an election by which he was irregularly made a captain-general, and then boldly undertook a military expedition without a royal charter.

Thus there is hardly a doubt, and his letters plainly indicate it, that his prime object in these reports was to so frame them as to secure imperial pardon for his offenses, as well as sanction to continue the conquest. Therefore, he pictured the El Dorado of which Spaniards were wont to dream, whose wealth would fill the emperor's depleted treasury, and whose greatness would augment the power of his realm. All that he saw and did was extravagantly colored in such language and terminology as would magnify his adventures, and at the same time picture the conquest of a country after the Spanish ideal. Besides this, he tells how the people were idolaters and human sacrificers; how he overturned their false idols and set up crosses and images of the Virgin in their stead; and how, by constant appeals to them to embrace the religion of the Spaniards, it pleased God to make him the means of converting many. Thus, by emphasizing his acts as religious, and giving his expedition the color of a holy war, did he also secure the necessary and powerful influence of the priests at court, who, in those days of a jealous Inquisition, the Romish sovereign dare not ignore.

These letters were dispatched by trusted messengers direct to his Majesty in Spain, and, that their object might be the more surely accomplished, a quantity of virgin gold was sent with one of them, which was either gathered from the Mexicans themselves or by the Spaniards with native aid.

These considerations should influence our judgment as to the truth of Cortes's Aztec story. Even Mr. Hubert Bancroft says that "he was ever ready with a lie when it suited his purpose," and that he sees in his letters "calculated misstatements both direct and negative." Dr. Robertson, too, though he accepts them as so much history, is forced to confess that such and such a statement "seems improbable."

Besides Cortes, however, both Gomora and Bernal Diaz speak of bronze and tin, but it is only in the single instance when the merchandise of the market-place is described. Gomora only enumerates the metals, without describing the form in which they were used, and Bernal Diaz's words are, "They had for sale bronze axes, copper, and tin."

But Gomora, it should be remembered, was Cortes's secretary and chaplain, and, as Dr. Robertson says, he probably composed his work at his master's dictation, we naturally expect him to repeat the latter's highly-colored and delusive account of Aztec art. If he obtained versions from other lips besides his master's, it was all doubtless recorded in the manner the latter desired. Indeed, Las Casas asserts this most positively, and in another place adds also the charge of "downright falsehood." Muñoz and Robertson have rejected him as a reliable authority, and even his contemporary, Bernal Diaz, has emphatically accused him of adulation and inaccuracy.

But Bernal Diaz himself can not be believed, and in him we have the last of the three authorities for aboriginal smelting. A reading of his work alone would lead the educated mind of to-day to doubt the best part of what he describes. Though he denounces the figures of Gomora as eight times too large, his own remain plainly extravagant: for instance, the number and population of the valley cities which he gives would be more than the natural conditions of the country could support. One hundred and thirty-eight years after the conquest Thomas Gage confessed himself sorely puzzled to account for the disappearance of these cities as described; and Mr. Lewis H. Morgan, in his "Houses and House-Life of the Aborigines," even rejects the idea of their actual existence. Mr. Morgan, I might say, discredits these three authors in nearly everything except the main acts of the Spaniards, and these, he says, are all that can be accepted as historical, while "the descriptions of Indian society and government are imaginary and delusive."

I was glad to see that Mr. David A. Wells, in the April, 1886, number of this magazine, took the same view. He says that the popular idea of the civilization of ancient Mexico has very little foundation, and the fascinating narrations of Prescott as well as the Spanish chronicles from which he drew his so-called historic data, are little other than the merest romance, not much more worthy, in fact, of respect and credence than the equally fascinating stories of 'Sindbad the Sailor.' And in defense of this conclusion he calls attention, among other things, to the fact that the relics in the Museum of Mexico, which are probably the best collection of the remains of the so-called Aztec people that ever has been gathered, are very little better than those from the Western mounds and some of the Indian tribes of the United States.

Though it is a harder task to impeach the motives and work of Bernal Diaz than those of Cortes and Gomora, we must nevertheless consider that his original manuscript slumbered unpublished in private hands for fifty years after his death, and then was printed for the first time in Spain under a censorship decree by Alonzo Remon, a Franciscan priest. Brasseur de Bourbourg says he saw the original manuscript in Guatemala; and Scherzer, who also saw it there, informs us that the text, as published, is very incorrect. Moreover, in Rivadeneyra's "Historiadores Primitivos de Indias," tom. ii, we find that the above edition of Padre Remon, first appeared in 1675 in Guatemala, although it was printed in 1632! Thereupon, Señor Fuentes, a descendant of Bernal Diaz, said that "it contained in some parts more and in others less than my great-grandfather wrote." He added, also, that the title on the original cover, which the family have preserved and kept in sight, is simply "Ancianidad Manuscrito," and not "Historia Verdadera de la Conquista de la Nueva España, por el Capitan Bernal Diaz del Castilo, un de los Conquistadores." We learn also from the above authority that the inaccuracy commences at the very beginning of the narrative, for the opening words are not those given in the printed edition.

Thus there is scarcely a doubt that, in the process of copying, changes greater or less were made; and, since the work had to receive the sanction of the Inquisition, it is not unlikely that it was changed to conform, in certain necessary and possible features, to the records already licensed which emphasized the conquest as a triumph of the Church. It is not unlikely, also, that by this time a better knowledge of the conquered land and people had led many to doubt much that Cortes and Gomora had described, and, though dead fifty years, Bernal Diaz was thus brought forward as a convenient corroborative authority.

In this connection it is not a little significant that Bernal Diaz is an extremely zealous churchman, and that the expressions which he, an unlearned soldier, uses, correspond almost precisely to those which characterize the writings of the priests of that period. His narrative is filled throughout with religious observations and considerable emphasis is given to acts done in aid of the Church.

Moreover, we notice that he resents the imputations of Las Casas of inhumanity and inaccuracy. This is especially noteworthy when we consider that while at Guatemala in 1560 he could not have known what Las Casas had written, for the latter's "Historia General" was not completed when that author died in 1561, and then his injunction that no one should use it for forty years after his death must have been strictly obeyed.

But whether the Remon edition of Bernal Diaz be a true copy or not, we can not at any rate reconcile our knowledge of Mexican topography and resources with much that he therein relates; and as for his elaborate particulars of Mexican art and civilization, they are so plainly idealistic that our common sense forbids us to believe them. Even Mr. Prescott contends that "the more intimate our acquaintance with his narrative the less is our confidence in the accuracy of his details."

Besides Cortes and Bernal Diaz, however, there are two other authorities who were eye-witnesses of Mexican art before the conquest. These were the so-called Anonymous Conqueror and Andres de Tapia. Both were Cortes's captains, and both have left personal accounts of what they saw, which Icazbalceta has recently taken from their obscurity and published in his "Coleccion de Documentos para la Historia de Mexico." The Anonymous Conqueror gives a full description of Mexico, its country, resources, people, and customs, but, in his detailed account of the Mexican market-place, its separate stalls and the various articles on sale therein, there is no mention of any metal except gold. Mr. Hubert Bancroft has properly said of this writer that "his method and language denote intelligence and inspire confidence. Dealing wholly with native institutions he seems to have no desire as is the case with some to magnify native strength and resources for the sake of raising the estimate of the deeds of himself and comrades.

His whole narrative bears the stamp of reliability, and the student may easily from internal evidence and comparison deduct approximate truth."

Andres de Tapia, on the other hand, describes the march against Mexico as well as all that was seen and done upon its entry, and although apparently a panegyrist of the conqueror, he is absolutely silent concerning the elaborate silver presents which he is said to have received. Neither does he testify to the bronze, lead, and tin of the Mexican market. Our confidence in Cortes and Bernal Diaz, the other two eye-witnesses, being impaired, these facts should be given no little significance. There is one instance, however, in which Tapia mentions silver, and in this he says that "Montezuma's treasures of gold, silver, and greenstones, of not very fine quality, were shown to himself and another Spaniard in the Casa de las Aves," or the House of the Birds.

Another contemporary writer who is of unquestionable authority is Bernadino de Sahagun. He was a Franciscan priest, and came to Mexico eight years after the conquest. He studied the native tongue, and became more proficient in it than any other Spaniard. He studied also the motives, lives, and thoughts of the natives and got from them their hieroglyphics which he expressed in the Roman character. His work is composed from the evidence in large part of Aztec eye-witnesses, and these are mingled, though somewhat confusedly, with recollections from old Spanish soldiers. He gives considerable space to the arts of the natives and their manner of work, and though he speaks of their work in gold, and this as performed with the hammer, he fails to furnish any information in regard to silver, bronze, and tin. Now, if the ancient Mexicans separated tin from its ore and knew how to fuse it with copper to make bronze, it must certainly be considered strange that Sahagun so soon after the conquest neither saw a relic thereof, nor obtained from the surviving Aztecs any account of their skill in this regard. Sahagun, moreover, in his twelfth book, gives a full description of the conquest. Herein he describes in detail the presents of gold, feathers, etc., which Montezuma made at different times to Cortes, but he is careful to omit all mention of any of silver. Not a word about that wonderful silver disk that represented the moon, neither any mention of what we deem still more wonderful, namely, that lead, tin, and bronze were seen on sale in the market-place of the conquered city. He would indeed be remiss in his duty as an historian should he omit all mention of a feature so singular and important were he confident that it was true. All that he has to narrate, concerning the metals that the Spaniards saw in Mexico, is that Montezuma showed them a hall where were stored bright feathers, "and many rich trinkets of plumes, gold, and stones," and then when the Spaniards expressed their desire to see the contents of his private chamber, which was called "Totocalco," or the House of the Birds, they saw therein "many trinkets of gold and silver, all of which they took away."

These facts demand particular attention when it is known that this account of the expedition was composed upon the evidence of surviving natives, and the recollections of disinterested soldiers.

We desire to refer in this connection to the fact that Sahagun's vague and only mention of silver, namely, that it was seen with gold, feathers, and stones in Montezuma's private chamber, called Totocalco, or the House of the Birds, is also the only one of which the eye-witness Tapia speaks. The latter frankly says that "trinkets of gold, silver, and greenstones of not very fine quality, were shown to himself and another Spaniard in the House of the Birds" (Casa de las Aves).

These two sober accounts can not be impeached. They are the testimony of eye-witnesses who had no thoughts of how their stories could secure the censor's license. The one innocently confirms the other, and we are forced to accept them as giving us an honest, truthful picture of just what metals the Spaniards actually saw.

Thus we have presented everything upon which the historic view of our subject can properly and authoritatively rest. We can not, however, conscientiously believe the best part of the somewhat idealized stories of Cortes and Bernal Diaz, for we have seen how Cortes's letters were influenced by his ambition, and why the printed edition of Diaz can not be accepted as a *verbatim* copy of his original manuscript. Besides this, not only do the natural conditions of the country refute many of their statements, but, strange to say, nowhere in all our archæologic archives is there to be found a single relic of the wealth and elaborate conveniences that they describe. We accordingly feel warranted in discrediting this much of what they say, namely, that Diaz once saw for sale "axes of bronze," and Cortes "trinkets of lead, bronze, and tin," in Mexico, and tin coins among the natives of Tasco.

A careful examination, both of the ancient pictures and the early chronicles, does not develop the fact that copper, much less bronze, was ever employed by the natives in implements of war. Scarcely anything either is said concerning metal tools. Diaz is the only man who is said to have seen some, and these were axes only, but neither he nor any one else saw one in actual use. These facts can not be reconciled with the idea that they worked so extensively as to have, as Baron Humboldt says, galleries and shafts, and that they smelted the ore, and alloyed the refined metal to make bronze.

We are not surprised when the records tell us of so much gold, nor even of silver in Mexico, but we would be if they contained anything that spoke of an extensive use of copper, for we know that native copper in Mexico is found only in a very limited degree. This native copper, with perhaps some that came from Lake Superior, through an extensive traffic, was doubtless all that they possessed.

It may be asked, however, how came their temples, and such works as the so-called Calendar Stone, for instance, so exquisitely carved, if they knew not the use of bronze? As for their temples, Mr. Norman has told us that most of them are composed of a fine concrete limestone, in the carving of which "flint was undoubtedly used." Only implements of flint, obsidian, and other stones, and copper have been found among these ruins, and this fact rather encourages the belief that the natives carved these stones when first taken from the quarry, in their soft condition, with tools of this description, the rock afterward becoming hard on exposure to the air. Herrera, speaking of the districts of Yucatan, distinctly tells us that "in all of them there were so many and such stately stone buildings, that it was amazing, and the greatest wonder is that, having no use of any metal, they were able to raise such structures." Landa, too, who was a contemporary of the conquest, adds his testimony by saying that "there exist many beautiful structures of masonry in Yucatan, all of them built of stone, and showing the finest workmanship, *the most astonishing that ever were discovered in the Indies*, and we can not wonder at it enough, because there is not any class of metal in this country by which such works could be accomplished."

The so-called Calendar and Sacrificial Stones unearthed in the city of Mexico, and most of their idols, are made from large blocks of basalt, and to dress or carve this very hard volcanic material with a bronze chisel, however well it may be tempered, is impossible. A process of grinding and rubbing, which archæologists have now demonstrated to be extremely practicable, and in which the Mexicans, as in other things, became more expert than their northern brethren, was doubtless the only means employed.

The remains of native work in bas relief are now known to be very numerous, but neither among the ruins of Palenque, Uxmal, Copan, Chichen, nor Mitla can there be found a single metal tool. Had these extensive works been fashioned with bronze implements, far more specimens than the paltry three that we have would have come to light ere now, within the broad area in which they are embraced.

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President Barnard reviews the subject of elective studies in his annual report of Columbia College. He thinks that during the growing period of the mind the studies should be prescribed, for discipline, and to discover the bent of the mind. They should, at the same time, be so varied as to offer every faculty of the mind an equal inducement for exertion. The preference will then be free to manifest itself. The time for introducing the elective element should be fixed, then, rather with reference to maturity of years than to the degree of advancement in the four years' round of college study. This, with the average of college students, appears to be attained in the nineteenth or twentieth year; an age which corresponds, in most students, nearly with the end of the sophomore year.

# CHANGES IN THE ASPECT OF MARS.

By STANISLAUS MEUNIER.

THE planet Mars has for a long time signalized itself to observers by the remarkable traits of its constitution. In consequence of its relative nearness, the telescope has been able to furnish us with a number of data respecting its physical geography and its meteorology; and it has been a very rich source of results concerning the philosophy of the solar system and the physical universe in general.

It is well known that Mars displays some bright spots, and others dark, of which we have every reason to consider the former to be continents, the latter seas. Toward the poles appear large white zones, varying in size at different times, which are caps of ice, susceptible of occasional breakings-up like our icebergs. In the thin and transparent atmosphere we can distinguish clouds, currents, and sometimes whirlwinds quite like the cyclones that rage among us.

Besides these intimate analogies with the earth, the study of Mars reveals especial features, some of which are most satisfactorily explained by considerations of comparative geology. With the tenuity of the atmosphere is associated a much smaller extension of the seas, and the relative repartition of land and water is very different from what prevails on the earth. Astronomers observe, as one of the most remarkable peculiarities of the surface of this planetary neighbor of ours, a large number of long and narrow passages and seas like bottle-necks. In our globe the oceans are of three times the surface of the continents; and Europe, Asia, and Africa form together a single island, while another island is formed by the union of the two Americas. But, on Mars, an almost complete equality exists between the surfaces occupied by the continents and by the seas. Further, they are mingled with one another in such a complicated manner that a traveler might visit nearly all the quarters of the planet, either by land or by boat, without having to leave the element on which he began his journey.

This much assumed, it should be recollected that Mars is older in the planetary series than the earth; that is, having been individualized at a more ancient period, and having a smaller volume, it has reached a more advanced stage in the sidereal evolution. Hence the planet represents now, in its great lines and independent of its individual characteristics, a condition which the earth will ultimately attain. One of the effects of the secular cooling of the earth is to determine the progressive absorption of the waters of the ocean by the successively consolidated rocky masses. Hence a striking comparison might be made between the present Martial seas and the terrestrial oceans after we shall have supposed they have been in a more or less great part absorbed. The results of innumerable soundings have permitted the construction of bathymetric charts of our oceans; and thirteen years ago I described the form of the Atlantic Ocean at four thousand metres below the present surface as "bottle-necked." If, then, we suppose the water of the Atlantic to become absorbed in the profound masses at this moment in process of solidification, in such a way that the level of that ocean shall be depressed by four thousand metres, we shall have at the same time a much smaller surface covered by water, and a narrow and elongated form of the seas, or exactly the conditions which Mars presents. At the same time that the water is thus drunken up, the air also will be undergoing absorption. All the rocks are aërated. We know what trouble we have in driving the air from even the most compact rock of which we wish to obtain the density with precision. Since the different mineral masses become aërated while they are becoming moist, and consequently, while they are cooling, the atmospheric strata should undergo a progressive decrease. It is, therefore, natural that the atmosphere of Mars should be much thinner than that of the earth; and that is an excellent condition for the telescopic study of the planet.

For the earth, geology furnishes a kind of indirect confirmation of this progressing absorption of the atmosphere. The results of the experiments of physicists, of Mr. Tyndall in particular, go to show that a slight augmentation in the thickness of our atmosphere or in the proportion of vapor it contains, would suffice to cause the solar heat to be stored in larger quantity and wasted more slowly; that is, in short, would make what we call climates disappear—a warm and nearly equable temperature prevailing over all the earth. Now, one of the most remarkable characteristics of the ancient geological periods is just this absence of climate, which is indicated by the uniformity of fauna and flora over the whole planet; and this confirms our opinion that the atmosphere once formed a much thicker bed than it does now.

While there thus exist traits in common between Mars and the earth, a strange motive of interest lies in the existence on the surface of the former globe of very important details of structure which are without analogy with us. M. Schiaparelli first perceived, in 1877, in the continents of Mars, which had been till then very large and without solution of continuity, a system of dark channels, often very slender, which divided the surface into a multitude of lands isolated and separated from one another like the meshes of a net. Notwithstanding the tenuity of these channels, they are not less than one hundred and twenty kilometres in breadth, while some of them are fully forty-eight hundred kilometres long. These results were at first received with incredulity by astronomers, who were afterward, however, constrained to recognize their rigorous exactness. The works of the distinguished director of the observatory at Milan upon this subject, of which the last one, relative to the opposition of 1879–'80, constitutes a quarto memoir of one hundred and nine pages and six plates, are very interesting.

But it is since this magnificent publication appeared that the author, on the occasion of the opposition of Mars of 1881–'82, was a witness of some marvelous changes which are fully described in a memoir that has not yet appeared, but which M. Schiaparelli has kindly sent me. It appears from these observations, and from others which were made between 1884 and 1886, that Mars is at this moment the theatre of phenomena of stupendous grandeur which will be adequate in a few years to impress profound changes in its aspect. The views taken by M. Schiaparelli show that a number of the channels previously described are doubling, or are being paralleled by similar ones having the same dimensions and directions. The appearance on the new map of the hemisphere is nearly the same, Dr. Terby, an eminent areographer, of Louvain, suggests, as would be produced in the former one by covering it with a double-refracting crystal. To this phenomenon, which has no analogy, M. Schiaparelli has given the name of the gemination of canals; and he has prepared a full memoir respecting it, which will shortly appear.

Although they were met at first with incredulity, these astonishing discoveries have received and are receiving constant confirmation from the observations of such men as Boeddicker and Burton in Ireland, M. Perrotin of the observatory at Nice, and his collaborators, MM. Trepied, Thollon, and Gautier. Other observers, like Messrs. Green, Knobel, and Denning, have not been so fortunate in verifying his facts, but their researches, published in the memoirs of the London Astronomical Society, and in the "Monthly Notices," are full of interest. It adds to the mystery that the gemination seems to be made gradually, though rapidly, and with progressive accentuation. Thus, the canal Nilus, at the junction of the eightieth meridian and parallel 20° north, is paralleled by another canal, which is very faintly marked and hardly visible in the older map. In the new map the two canals have a nearly equal intensity.

By careful comparison of Schroeter's designs, made a century ago, and Herschel's earlier ones, M. Terby has discovered analogous modifications on the Martial surface. Some of them are local enlargements of some of the seas, like that called Kaiser, and other changes in the details of configurations which had been supposed to be fixed. Of similar character is the memoir of M. Van de Sand Baghuyzen, in the "Annals of the Observatory of Leyden," in which the author interprets the designs of Schroeter and finds in them a trace of many of M. Schiaparelli's details. Père Lamey has also made many observations of Mars, which have led him to some original conclusions worthy of investigation.—*Translated for the Popular Science Monthly from La Nature.*

# EDUCATIONAL ENDOWMENTS.

By CHARLES S. ASHLEY.

THERE is so much sound philosophy on the present subject in a story related by that genial publication, the "Arkansaw Traveler," that we may be excused in departing from the severe dignity proper to a sociological essay in repeating it. It seems that down in Arkan*saw* there lives an old man named Billson, together with his son Dan, who is a close student. Billson was naturally proud of his son, and allowed the young man to remain in his room, deeply covered with the grand rubbish of ancient wisdom. During the busy season, when every hoe in the garden-patch was worth its weight in silver, Billson's neighbors would ask :

"Why don't you make Dan help you with your cotton?"

"He can't spare the time from his studies."

"Studying is all well enough ; but, do you think it would hurt him much to drop his books for a day or two, and take up a hoe? The grass is gaining on you."

The old man sighed and seriously reflected for many days. One morning he reverentially entered his son's room. Pointing to an open volume that lay on the young man's desk, he asked :

"What book is that?"

"Plato's Philosophy."

"Full of interestin' readin', I reckon."

"As grand thought as was ever expressed."

"Ain't law, is it?"

"Oh, no, it's philosophy."

"Yes, but what is philosophy?"

"O—er—well, it's er—it's the—soul of great men shaped into words."*

"Ah, hah! What does this here fellow Plato propose to larn you?"

"To be great, to look high."

"Yes, but does he tell you what to look at?"

"O—er—yes, he—that is, he tells you to purify your soul."

"Ah, hah! But what does he tell you to do with the body?"

"The body! Why, he scorns the body."

"Ah! Don't appear to have much use for it, eh?"

"He is higher than all things physical."

"Sorter silent on cotton, too, I reckon?"

"Why, father, what can you mean?"

"Wal, I'll tell you. Ain't got nothin' agin Ponto—"

* I pause to remark that I have known many a young person who, like Dan, was studying philosophy, and whose idea of the same was about as precise and intelligent as the above definition.

"Plato," the student suggested.

"Yes. I ain't got nothin' agin him, you understand, and reckon he may be a pretty clever fellow; but I'll tell you what's a fact. He ain't worth his salt when the grass is in the cotton; so, Dan, jus' grab that hoe hangin' in the tree out there, and scorn the grass, and larn the cotton to look up."

"Great goodness!" the affrighted young man exclaimed, "I can't stand it out there!"

"Oh, but you mustn't pay no attention to the body. The sun won't hurt your soul. Come on, or your grub stops."

The young man sighed, and like the scriptural personage, arose and followed his father. Two hours later a panting and perspiring Platonist wielding a heavy hoe was seen striking at the fox-tail grass.

This story illustrates the superstition and ignorance which have characterized the great mass of mankind regarding educational matters. It is a fact at this day that the vast majority of pupils in attendance at our colleges do not know what they want. It is also a fact that the parents who send them do not know what value their children are to get for the sacrifice made. They have a vague idea that their children are to be "educated," and are accordingly to take their place among the first of the land. This simple conception is carefully coddled at commencements, where the public are congratulated on the fact that they are to be taken under the protecting wing of the "educated" (i. e., the college-bred) man. The common people are elegantly assured that they will be supremely blessed, in some mysterious and unspecified manner, by the presence of "educated" men among them; while at the same time it appears that the "educated" man will have a very nice and agreeable job in taking care of the public. And the amazing superstition that a study of books (and those, too, almost irrespective of the wants of either pupil or public) is education, persists in defiance of all sense and experience.

The same simple faith appears in the making of charitable bequests. No statistics regarding educational endowments are afforded by the census, nor are any at hand, hence the subject can not be presented in its full aspect. But we know that endowments are daily announced in the newspapers. Young men and women are to be hired to study theology by means of fellowships, to look at the stars, to study the languages, and the sciences, or whatever the whim of the "benefactor" happens to be. The climax is reached when, as was lately announced in the London "Times," an immense sum is set aside from the ordinary course of business to aid young men in becoming civil engineers. That education, if valuable, should be paid for like everything else of value; that it should stand on the same footing as all other things, and that its value is best secured by its ability to appeal to the spontaneous desires of the public, and to win its financial support precisely as Booth or Patti or Theodore Thomas win their support—that is to say, by receiving value for value given—seems to be a conception which, though it has reached many people in a confused way, has not yet penetrated educational circles. These, like the clergy in former times, imagine themselves independent of the rules governing other men in the struggle for existence, and demand support as a caste, independently of the quality of the individual service rendered, or the amount of demand for it. This is the attitude of college men as a body. They have not yet accommodated themselves to the new age, which recognizes no privilege. And this feeling likewise governs the law, which still permits men to set up perpetuities, and control the administration of wealth years after they are in their graves, and after a society of which they had no idea has arisen.

The explanation is not as simple as the fact is plain. It is that with the advance of the United States to the position of the wealthiest nation of the earth, the wealthy and fashionable classes have naturally reverted to European standards in education and fashion, and thus a collegiate system which once fulfilled a real need in Europe, has been transplanted into our own uncongenial soil. For it is true that even the churning of Latin and Greek into unwilling minds once had its use; as is also true of slavery, of the feudal system, of church establishments, and of all other things. That use consisted in the social discipline involved in the creation of a class united by common interests and ideas which could assist the ecclesiastics and the police in restraining the barbaric vulgar. When modern educational institutions were founded the great necessity of society was the repression of lawlessness, of private war, and of all the elements making for social disorganization. Under the supreme instinct of self-preservation every nation in Europe put forth vast institutions to uphold order and some semblance of law. The feudal system, ecclesiastical power, monarchy, and education, were the chief engines evolved for this purpose. In turn, or at the same time, they fulfilled the need which produced them; and since then they have each slowly declined and are rapidly being forced to adapt themselves to the changed condition of mankind. But every institution retains the instincts which gave it birth; the tendency of every structure is to persist in that mode of activity with which it starts. So we find the aristocracy of England still "willin'," like Barkis, to take care of the people, in spite of the ungrateful and altogether improper ridicule of men like Mr. Labouchere; and the late book of Mr. Mallock, "The Old Order changes," is extremely interesting and instructive, both as the latest expression of this pleasing willingness and in the ferocity with which it treats those who object to being taken care of.* So with ecclesiastical systems, in their decline as an autocratic caste, the same mediæval instincts show

* Of Japhet Snapper (a caricature of a leading radical politician) he says, "his desire to abolish the aristocracy is only a fermentation of his desire to lick their shoes." This is pleasant.

themselves; and the same resistance to changed conditions appear. In Escott's "England" is an idealized picture of the typical rector, in which the good man's heroic labors are pathetically set forth in such strains that one is reduced to absolute wonder that men like John Bright can be so perverse as to advocate disestablishment; though indeed he might be excused on the ground that the clergy must be prevented from altogether sacrificing themselves on the altar of their country.* And in America a like fact appears in the military and naval service. If the naval officers could have their way, we would at once begin to discount the nations of Europe in building ruinous engines for killing our fellow-Christians; and the soldiers would likewise have an enormous standing army perpetually fighting the air on dress-parade. And now, to come to the immediate subject in hand, the same truth holds with regard to education. The European system was introduced into this country, and, though it has been forced to change very extensively, it has held its ground with wonderful tenacity. The primal distinction from one which would naturally grow up here is not in the subjects offered for study but in the method of maintenance. The European system assumes that people do not know what they need, and that it must be offered to them gratis. In America we recognize the contrary to be true in nearly all the concerns of life—in religious establishments, in the militia, and latterly in most college curricula.

In this paper I propose to pass in review the operation of educational endowments both past and present. Having admitted that the artificial support of education had at one time its social justification, we shall confine ourselves to the inquiry, Have endowments been productive of the progress of knowledge and sound education from the individual standpoint? For it will scarcely be pretended that in these days this mode of education is a necessary means of preserving order. That end is now subserved by commerce and the vast interdependence which complicated and specialized systems of production and exchange involve. The province of education in our day has become narrowed like all others, and—speaking, of course, of higher education—is now simply the bestowal of needed knowledge. We shall address ourselves to the inquiry as to whether endowments are a suitable means for the diffusion of knowledge by a brief examination of the history of the English schools and universities, and by a short study of their present operation in this country.

The history of Oxford is deeply involved with that of the general mass of British society. It is first known as poor and democratic. In the early part of the fourteenth century it is said that as many as

* The Archbishop of Canterbury, for example, sacrifices himself to the extent of taking a salary of $75,000 a year. Every one must feel sorry for the archbishop; especially when it is considered that he has to live in a palace rent free and to endure the terrific labor of crowning kings and the like.

thirty thousand students were in attendance; and Huber, the learned historian of the universities, says that "the intellectual importance of Oxford at that period is universally acknowledged." At this time the university had none but rented buildings, and little or no land. Endowments did not exist, and every teacher was left to find his own level. The Church and the government now attained a more efficient organization, however, and laid hands upon the universities. The means by which the university became a stepping-stone to the Church and an appendage to the government are not very clear. Monasteries and endowments encouraged the cultivation of such learning as the ecclesiastics considered genuine. The Church and the government gradually acquired intimate and stable relations; and the end of the process was that Oxford, and Cambridge as well, became aristocratic institutions, whose aims and ideas were those of the ruling classes, and whose characters became sociological or political rather than educational. Huber * has the following remarkable passage on this point:

"After attaining its greatest external privileges a new process commenced in the university. The number of students diminished but endowments kept increasing, and of course democracy waned rapidly. . . . The university became gradually more dependent on fixed possessions and assumed a new impress. It was of course more aristocratic; and did not wholly escape the deadening influence of worldly goods."

Surprising as it may seem, Oxford seems never since to have attained any considerable importance intellectually. From the writings of a contemporary, we learn that the gownsmen became "swollen in mind" and indifferent to learning. Gradually the university became filled with the younger sons of the gentry, who went to the university as the means of ecclesiastical preferment. It is unnecessary to rehearse the facts here summed up; I do not know that they are seriously disputed. Politically, it is well known that the universities have been millstones on the necks of the English people. No progress has been made that they could prevent. Ever fawning on power, they have made it their principal business to obtain pecuniary favors from the government. In this they have been very successful. They early acquired the sole right of presentation to ecclesiastical livings by the bishops and others, and, according to Professor Thorold Rogers, "there would not remain one fifth of the present number of students" without this stimulus. Professor Newman, the translator of Huber, states the effect of all this on Oxford in our own century. "An artificial monopoly," he says, "is given to a few accomplishments. . . . And here I speak not of the (neglect of the) physical sciences and mathematics—*the taste for all which in the University of Oxford has in very recent years actually declined—but, confining our view to the circle of studies which constituted the original basis of the universities,* it is extraordinary to see the neglect and decay into which the majority

* "History of the English Universities," vol. i, p. 76, English translation.

of them have fallen. . . . I appeal to any Oxonian whether—with the exception of the Latin and Greek languages and a fair proportion of the corresponding history—there is any one of these subjects for which Oxford is even a third-rate school." He goes on to relate that, when he himself was in Oxford, the candidate for the degree of Doctor of Divinity implied no theological learning whatever; "a candidate had simply to read aloud an old composition lent him by the clerk—it mattered not what, so that it lasted an hour—and this was his sufficient scientific qualification." * Parliament has made various imbecile attempts to improve the vast corruption which is in the universities the fountain-head of the English Church, and the Salisbury government have announced another. None of them has reached the seat of the disease, which is the arbitrary bestowal of rewards and positions without service rendered. Class interest has hitherto been too strong for reform, just as it long was in upholding the practice of purchasing commissions in the army; and Oxford, with ludicrous pageant and solemnity, continues to spend its income of above two million dollars in repressing the progress and intellect of England.

It might be expected that the great schools of England—Eton, Rugby, Harrow, Westminster, and others of that class—would display like characteristics; and, indeed, evidence on this point is sufficiently abundant. In 1861 public clamor induced Parliament to appoint a commission to investigate these institutions, and it unearthed a mass of corruption and absurd practices such as staggers belief. Here the facts can only be briefly summarized. It was found that the revenues of the institution were absorbed by those in control. Head-masters received from twenty to thirty-five thousand dollars annually, besides the right of presentation to numerous church livings, and the Fellows contrived to appropriate most of what the head-masters left. There was found to be an astonishing dearth of general culture among the students: few newspapers were read, Shakespeare and Milton were hardly known, and even Scott and Thackeray were too heavy for the "disciplined" brains of most of the students. Science was an unknown field. Music, geography, history, and drawing were likewise conspicuous by their absence. One of the schools introduced mathematics as late as 1845, and one graduate was found who did not know that there was such a thing as the multiplication-table! The same thing appears everywhere.

The quality of beer and mutton which supported the students in their arduous intellectual labors was found to have been uniformly bad through several generations; the practice of giving bad beer and bad mutton had ingrained itself into the noble British constitution, and could not be changed. One of the provosts testified before the committee that he objected to the teaching of science, "because it is scarcely seventy years old." English literature and composition were

* Introduction to Huber, pp. xxv–xxvii.

absolutely neglected. And, to crown all, it was found that even in the classics no satisfactory work was done. Few of the pupils could read even Latin with any ease, and none were ever asked to do so at sight. It would have been useless.*

Certainly no such state of affairs can be found in any American institution. But there are facts in plenty with the same bearing. Dissociate a body of men from their fellow-citizens, set up an independent caste by endowing it financially, and the consequences appear even in a country where public opinion is as omnipotent as here. The difficulty of forcing progressive action on our colleges is a sufficient illustration. We live in an age of unparalleled "passion, pulse, and power"—an age with gigantic problems suddenly laid on it; our civilization is chiefly industrial, and the railway, the factory, and labor organizations are the largest elements of our social life. Would any one believe *a priori* that under these circumstances our colleges would be still haggling over the Greek and Latin question, and that only one of them in the entire country should give instruction on railway transportation, the most important subject now before the public, and the one also on which there is such vast ignorance? † This, however, is only one instance of the disgusting narrowness of the professorial intellect as "stimulated" by endowments. Everywhere we find a total want of connection between the colleges—especially those old and rich—and the life of the people. Go into a university library, and, after listening to the complaints of the librarian about the paltry sums at his disposal, you will find splendid and expensive editions of Percy's "Reliques," Scott's "Dryden," hundreds of volumes of pedantic discussion about Shakespeare, and you will look in vain probably for the great newspapers which so faithfully reflect the nation's life; and "Bradstreets," "The Railroad Gazette," and frequently even "The Century," "Harper's," "The Forum," and "The Popular Science Monthly" will also be wanting. Recent American literature is treated with similar disdain. The want of direct responsibility to the public is felt in all directions. When a railway corporation discovers that a man is incompetent, it discharges him; a newspaper takes care not to retain poor writers. But no incapacity is so great that a college position, once gained, need be lost. Go through any of our great institutions, and you will find that year after year the same complaints have been made by students regarding their instructors. These have produced no effect, because the stimulus of duty not re-enforced by interest is not sufficient. It is a disagreeable thing to discharge a man, and it is not done when the authorities have no personal interest in the matter. Thus college professorships in this country come to a pass

* I shall be suspected of heightening this picture. I can only refer to the report itself for confirmation.

† Yale is the college referred to. Harvard has recently announced a series of lectures dealing with railways.

shown frequently in the "livings" of the English Church—mere sinecures, involving little labor, much reward, and great security for dullness and incapacity.* Relieved from the necessity of rendering service which will be spontaneously recognized, the irresistible tendency of weak human nature is to desist from the hard toil which such service demands, and to take refuge, gradually and unconsciously, in doing what will satisfy the powers that be ; in high pretense instead of actual performance, and in pedantry instead of sound learning.

And testimony is not wanting to show that the vast success of Oxford and the aristocratic schools of England in producing ignorant dunces is paralleled, fortunately on a milder scale, in this country. In a recent paper in "The Forum," President Robinson speaks of various disadvantages suffered by himself when in college :

"To add to my misfortune, the most intimate of my friends, though pure in their lives, and morally wholesome as associates, were low in their aims as scholars, satisfied with very little and very superficial work. They had been sent to college to prepare for the ministry, and were fair specimens of the average of a class of men not yet wholly extinct. Selected and aided by beneficiary funds as 'candidates for the ministry,' they seemed to regard themselves as absolved from the duty of high aims as scholars, and dropped into the wretched cant of 'laying aside ambition as unworthy the servants of the Lord.'" "The Nation" comments on this by saying that the same thing "is true of a larger part of the men who go to many of our colleges to-day under similar conditions"—that is, on a charitable basis. And it further observes that, "if he had followed these men out into life, he would have had little difficulty in showing that their effect upon the moral and political influence of the pulpit had also been a misfortune." There is nothing strange in this. Mendicancy is equally bad in its effects on the beneficiary and on the public.

A glance through the catalogues of the leading American institutions will justify the opinion expressed as to the total irrelation bred by endowments between public demand and educational supply. In Harvard, the leading university of the country, we find courses of study on the following languages among others : Hebrew, Aramaic, Assyrian, Arabic, Ethiopic, Sanskrit, Old Iranian, Pali. This in a university which offers little instruction on the greatest problems confronting the people of the present age. And in the University of Michigan, at which I took a degree, the same general facts appear, notwithstanding a closer responsibility to public opinion than Harvard is subjected to. A short time ago I visited the university, going to hear a classmate of mine instruct a class in Lysias. He is an excellent in-

* So it is with endowed libraries. The Lenox and Astor Libraries of New York are good illustrations both of the high expectations with which such institutions are founded, and of subsequent disappointment. They are closed for long vacations, and are open for few hours during their season (and *those* are inconvenient).

structor, but no art can infuse life into the subject. It was perfectly easy to see that the class was deriving no mental pabulum from Lysias, and that their minds were chiefly occupied with their chances of escaping a "flunk." There may be considerable literary merit in Lysias, but the class did not see it or care to look for it. They were exclusively occupied with the difficulty of translation and grammatical construction, and the whole process, as compared with real education, struck me as very like gum-chewing as compared with eating. The empty form is gone through with, but there is no nutrition. And even in the most popular courses, like the "seminary" in English literature, the same fact stands out in bold relief. The class study More's "Utopia," Spenser's "Faerie Queen," and the like, Tennyson's "Princess" being the only masterpiece in the course, except "Silas Marner," which has been written in any recent time. When I visited the class, it was striving, with very little success, to seem interested in Wordsworth's "Excursion." There may have been one member of the class who really had a spontaneous appreciation of the poem, but I do not believe there were more. After visiting even the best institutions artificially supported on the European plan, we are forced to think of the profound remark of Bagehot, that "academies are asylums of the ideas and tastes of the last age."

If the harm done by endowments consisted simply in a support of old-fashioned methods and subjects in education, it would be bad enough. But the trouble does not end there. There is a morbid, or what President Cleveland would call a pernicious, activity about them. What energy they have they use in actively obstructing the march of ideas and of political freedom. Oxford's history in this respect is too notorious to admit of further mention. Harvard, too, can tell her story. She has her Memorial Hall now for her sons who fell in the war of the rebellion; but time was when Senator Sumner was conspicuously slighted by her, and when Wendell Phillips was tabooed. Narrow sympathies, extending only to the prevailing power, have characterized "fair Harvard," as well as Oxford and the established Church in England. This is not due to the individual characteristics of the men who are for the time being in these institutions, but to a general law obtaining among privileged castes and corporations. And at this day, among the most prominent professors, we may find illustrations of this truth. It is not Oxford bishops alone who, from a class instinct, are the perpetual barriers of progress and the ardent champions of all that we have nearly outgrown, whether in education, political economy, barbaric criminal codes, and indefensible wars; in all of which the records of Parliament throw a singularly unfavorable light upon the English successors of the apostles, as may be seen in their adherence to the old education, in their resistance to the reform of the savage criminal code of England in the early part of this century, in their well-nigh unanimous support of the corn laws, and in their equally united support of such wretched acts as the war on Egypt and that in the Soudan. In our own country our endowed fellow-citizens, the professorial socialists, are a corresponding class. It is the instinct of self-preservation in privileged classes to cringe to power, and to express its sentiments; and when, as in our own day, powerful organizations rise, and, exhibiting a great revulsion toward an ancient form of social organization, seem likely to be in the ascendant, these classes hasten to pay court to the brute force of ignorance and numbers, as in other countries they pay court to the majority of bayonets. It matters not to them that social evolution is a continuous progress toward individual property and rights. It matters not that the English race in England and America have, after centuries of struggle and the sacrifice of countless heroic lives, secured individual immunity from official tyranny. The unprecedented rapidity of our recent advance has favored a reaction, and those last to follow in the wake of progress are the swiftest in retreat. But particular illustrations of this fact are necessary. We might cite the astonishing article of President Seelye in "The Forum," advocating *in America* the establishment of a national church! But we prefer to select the most prominent of the professorial socialists, whose recent utterances on economic topics are extremely interesting from our present point of view.

Mr. Richard T. Ely's "Introduction to the Labor Problem" is apparently a hastily written paper, and it might be unfair to subject it to any close scrutiny, were it not for the confidence with which the most startling statements are made, and the like carelessness exhibited in his other writings. The following is one of the gems of thought found in the place referred to: "The idea of free governments is to stimulate individual initiative and individual industry, but the consequence is that a few clever or fortunate people—often successful because more unscrupulous than others—restrict the activity of their fellows, and effectually repress the freest expansion of the energies of the people."

In the first place, the idea of free governments is not to "stimulate" anybody or anything, but simply the removal of obstacles in the way of activity, and the use of the word shows a fundamental misconception. Passing this point, however, one might suppose from the above that Russia and China, where Mr. Ely's sociological ideas have full sway, are better situated for a free "expansion of the energies of the people," whereas it need hardly be said that individual initiative *is* freest and individual industry *is* most successful where governments interfere least.*

"The ethical duties and the holy privileges of a citizen of the republic must be enforced in season and out of season," further remarks Mr. Ely. This luminous dictum is delivered without explanation; and

* The fact that, since the absorption of the telegraph lines by the British Government, all the improvements have come from America, whereas England had before furnished her full share of them, is a striking illustration.

perhaps it is just as well that none was attempted, for it is greatly to be feared that none is possible. It is worth instancing, however, as exhibiting the sanctimonious pomp and official carelessness of the author's style of writing and thinking.

But our next quotation is more interesting still: "Take compulsory education. The compulsion is a power which gradually lifts [a] people above its own ethical plain" (*sic*).

I confess that this last sentence reminded me of certain Canadian rustics who were gulled into believing that a man could lift himself into the air by pulling at his boot-straps. The parallelism is perfect, and in each case the implied denial of the persistence of force seems altogether *naïve* and unconscious. This passage is especially worth instancing, because it shows the weak point in all Mr. Ely's socialistic ideas. His constant assumption is, that governments can coerce the people—can expend force upon them—without itself being supplied with force by the people. The Government (if written with a capital letter) can support the people," whether the people "support the Government" or not. Now, everybody knows the fact to be, that no machine requires so much "pressure" to keep it going as a government agency. Public clamor has to reach a very high key before great measures are passed; endless log-rolling has to be resorted to before the best claim can be passed upon, or the bill most obviously good be enacted. And probably it is fortunate that this is so, for otherwise we should be even more inundated than at present with foolish legislation. But the point for our present notice is, that our Legislatures and executive agencies are inefficient machines requiring a vast amount of power for a given product, and that, too, of poor quality. This is not an accident, but is necessarily so. Legislative and executive bodies are unevolved in character, unspecialized by long discipline for the work they have to do; and this must continue to be so. And Mr. Ely ignores the commonest facts of daily experience as well as the highest generalization of science in the above quotation and in his whole theory of society, so far as he can be said to have one.

Were it worth while, we might continue quotations of this character *ad nauseam*. "Let us remember," he says, in the same Introduction, "that every hope of a permanent reform in industrial and social life must be illusory unless it has a firm foundation in a lasting state reformation." Let the reader observe the connotation of the terms "industrial and social." Does this mean that Congress is to give a "foundation" (whatever that may signify) for every social and industrial improvement? Congress, which can not even manage the tariff or the currency? In Mr. Ely's papers on railroads lately published in "Harper's," it appears that the State (with the big S) is to "reform" that branch of industry. But discussion is useless. Mr. Ely's expressions are so loose, and his papers ignore the commonest facts to such an extent, that argument is impossible.

We are, however, concerned with the sense or nonsense of the ideas of President Seelye, Mr. Ely, and their coterie of professorial socialists, only in a secondary degree. Our purpose is to show that the old Oxford spirit is being bred again in this country through the agency of highly-endowed educational institutions. Here, as always, where artificial protection is afforded to incapacity and mediævalism, we find the old neglect of facts, the old servility to prejudice and power, the same proneness toward the past, the same complacent carelessness and assurance of statement. Here, as ever, we find the old protective tone, the old ecclesiastical air—the old air of taking the public under the writer's wing. Had we space, numerous passages might be cited showing the patronizing and wholly foreign way in which the laboring-classes are regarded. And, of course, the same class-spirit is shown, as it always has been, in the bearing toward classes who are rising by their own unaided exertions to predominance (not, of course, of the political kind—else malign complexions would grow smiling) in the country. And the resistance of the Oxford bishops to Cobden and to Gladstone is singularly well paralleled by the jealousy shown by our endowed professors toward the great railroad managers, the great bankers and merchants and manufacturers, who are doing more for the comfort and happiness of mankind than any equal number of individuals in the world. And "The Nation's" remark (No. 1110), at the close of a review of one of Professor Ely's books, that "Dr. Ely seems to us to be seriously out of place in a university chair," was, while conceived in the right spirit, not literally true; for such men inevitably gravitate toward such positions.

Now, what is the *rationale* of the matter? Why is it that specially-protected classes acquire such a pronounced class instinct as is found in English clergy, in state officials, and in endowed professors? In the first place, every agency has a tendency to persist in those activities and modes of thought in which it set out; and when new agencies spring out of old ones, the result is the same. Thus, through educational institutions, the eighteenth century forces its ideas on the nineteenth, Europe on America, and Harvard on California and Michigan. Then there is the natural class jealousy, exhibited by all organisms; by France as against Germany, America as against England, labor against capital, spiritualist against materialist, by every man against a rival. And when endowments or state support render a class totally distinct and altogether independent of those influences which govern the rest of mankind, both causes work great effects. The result is similar to the coagulation of the blood caused by tying up a limb and preventing a free circulation within it. First there is annoyance, and then the isolated part becomes the seat of a disturbance which may threaten the life of the organism. I believe that any person who observes the air, the social temper, which surrounds educational institutions, especially those richly endowed, will find the effect spoken of not only in the government and the corporate character of the institution, but in the personal character of most of its officers. Many, very many exceptions must be made to such a statement; but, in the end it must be acknowledged that that stamp of action known as officialism leaves its mark upon the official; and that the individual as well as corporate influence of institutions thus artificially maintained, and animated by a different spirit and principle from that elsewhere prevailing in the body social, is hostile to the free movement, and an obstacle to a continuous healthful readjustment of ideas in our country.

Any general objection to the existing order of things inevitably meets the query, "What will you put in its place?" It is frequently assumed, so strong is the conservative instinct in mankind, that the objector, if he discovers or points out a disease, should also cure it. This hardly seems just. Nature puts forward one set of agencies for right criticism and another for right construction. Critics are seldom artists, and artists are seldom critics. Still, it is not difficult, in the present case, to give a more satisfactory answer. In the first place, it may be said that the objections brought against the foregoing are generally based on an overestimation of the function of academic education, both in individual and national life. The learned Huber remarks that the revival of learning in the fifteenth century, like the speculative movement of the twelfth century, "was sustained by the co-operation, not of institutions, but of individuals"; and this is also true, he says, "without a doubt, of every intellectual impulse which is animated by an independent principle of life." * This fact is evident enough both historically and from the *rationale* of all progress. I can not think of a single forward movement of society which has not been obliged to overcome the opposition of great educational centers; and hardly an eminent name occurs to me as having been assisted in its high destiny by academic education.† Whether in business, politics, or letters, the world's leaders have not been sent forth panoplied to conquer by their alma maters. It is with intellectual as with other progress. New developments arise, not from fixed types and structures, but by fresh movements from beneath; and the surface crust has always to be broken through before the new experience can displace the old in consciousness, and the new force has to break or bend the old structure in society before it can assume its rightful place. This is so obviously and so universally and necessarily true, that one may be surprised at the wide prevalence of the opposite

* Huber's "History of English Universities," vol. i, p. 216.

† A few Englishmen in several classes may be instanced as either having no connection with universities, or as deriving no profit from them. Burke, Bentham, J. S. Mill, Herbert Spencer, Davy, Faraday, Watt, the Stephensons, Lardner, Turner, Grote, Buckle, George Eliot, Thackeray, Dickens. Gladstone has been fifty years in getting Oxford out of him, and Grant Allen says that Darwin "escaped with comparatively little injury."

superstition. The surprise, however, will disappear on reflection. It has its origin just where reverence for kings, priests, and popes has its source—in the supreme need of mankind in early times for agencies maintaining social order and coherence.

This, however, is not a complete answer to the question, What is the substitute for endowed schools? But it renders the objection much less forcible than it might otherwise be. But if, notwithstanding the small share that institutions of learning really have in our national life, it still be thought that greater provision for them is necessary than commercial motives would lead to, it should probably be said that the best method of support is by direct annual grant from the state governments. Rough as is the relation thus established between a social structure and its function, it is clearly better than complete irresponsibility. Observation of institutions where this system of support is in vogue—as, for example, the University of Michigan—will, I think, strengthen this view. But I do not think there is any evidence whatever that education needs or can profit by artificial aid. Our colleges can be supported as our churches are supported; and, under a free and active business competition, there is quite as much reason to expect educational improvement as there is certainty of the superiority of our free churches over state establishments. But colleges are really an insignificant factor in education. Commerce, travel, newspapers, and books, spontaneously chosen, are the real educators. Whether in general literature or special science, the public is being served by periodicals printed for profit, and by voluntary societies of vast efficiency; and I think both newspapers and magazines might be named as exerting a greater educational influence, both from a public and from a personal point of view, than all the colleges in the country put together. Still further, schools are everywhere springing up on a business basis, because the most efficient men find they can make more money in this way than by bending to the dead level of existing institutions. And, surprising as it may seem at first sight, some of these schools might be named as not only giving better instruction, but as giving it at a smaller cost to the pupil, than endowed colleges, or those maintained by legislative grants. Business-colleges, lecture-bureaus, circulating libraries, magnificent art-stores, are fast supplying public wants, and would do so much more rapidly but for the prestige of the established system. And the genius of commerce, which fills our land with wonders despite foolish legislation and adverse public opinion, will surely triumph, like the Cinderella of our childhood, over her haughty sisters, who are vain rather of their age and status than of their works.

With the instinct of self-preservation, colleges have lately been adopting the elective system. The practical result of the elective system is that only those studies are chosen which fill some want, real or imaginary, and are offered by an agreeable professor. The final upshot is, then, that the students are made the supreme judges instead of the faculty; and that the professors are put on the natural competitive basis. And though their salaries are still paid by the corporation, the commercial principle is really in vogue, and its nominally becoming so is only a question of time. I remember a significant incident which took place during the last year of my attendance at the University of Michigan. It happened, accidentally, that two students published somewhat severe criticisms on the teaching of the professors in political economy and philosophy. Immediately afterward one of the professors, a very agreeable gentleman of the old school, educated in Germany, and a philosophical imperialist and absolutist to the core, delivered his sentiments on the subject. Amid the mingled cheers and hisses of his pupils, he attacked the presumption of the critical students. It was evident that in his mind things were going very badly. To him there was something wrong about a universe in which young men were permitted to have different opinions from their elders; and it is hardly too much to say that he was enraged. I could not help sympathizing with the vain struggles of an order which is rapidly passing away under the inevitable law of competition, and which, indeed, ought to pass away. And the resistance of President McCosh to *any* concessions to liberalism is an instinctive recognition of the fact that when they are once begun there is no ending. There is no stopping-place, no compromise, between the ancient system and that wherein every student chooses his studies and his teachers, and pays therefor. The small wedge of option being once introduced, there are incessant change and disturbance till this natural equilibrium is reached. If any one institution possessed an overpowering influence, its authority might check the advance for a time, but the competition for public favor between the five or six leading universities is so keen that each one is forced onward; and individuals, however conservative, and however many the degrees and titles that trail after their names, are unable to prevent the rapid adaptation of educational establishments to the demands of the public.

It has been the object of this paper to call attention to the facts that great endowed institutions of learning have not been efficient in the diffusion of knowledge, or as a means of intellectual progress; that, latterly, they have been useless and obstructive to the general march of society toward improvement; that the current system in America is an importation from Europe, and bears a scant relation to our requirements; that our colleges resemble, in their retrogressive characteristics and influences, their elder sisters in Europe; that their status in society is due rather to a superstition than to work performed; and that there is every reason to believe that educational facilities offered on a purely commercial basis, to which the elective system in the end inevitably comes, would be less costly to society as a whole, perhaps even less costly to students, and far more satisfactory. The policy of the law in giving individuals power to propagate their ideas for an indefinite period after death should be reversed, and their ideas should be put on the same footing as their preferences for individuals, to whom property can be limited for a few years only. In this case the monstrous egotism which leads to a large number of endowments would be cut off; and future generations would not be taxed in order that Jones or Robinson, dead fifty years since, might have the posthumous pleasure of having a college called after him. When competition and change in public sentiment have brought about this state of things, educators will have to let go of the cherished but unscientific idea that their judgment is better than the inclination and judgment combined of the students, and that it is their duty to force dull studies on unwilling minds. And the social organism will then, in this department also, carry on its processes of growth and development, waste and repair, in the same unfettered and natural manner in which the animal organism maintains and enlarges its life.*

## SKETCH OF PAUL GERVAIS.

PAUL GERVAIS was eminent as a zoölogist and as a paleontologist. Born in Paris on the 16th of September, 1816, he died in March, 1879, having lived a life exclusively devoted to science. By his entire consecration to study, says M. Blanchard in his "Eulogy," he reached the most enviable positions, conquering them with only his natural talents, courage, perseverance, and assiduity in work; for he had at the beginning of his career neither the resources which make existence easy, nor the certainties which give confidence as to the future. In early youth, yielding to his native tastes, he was accustomed to frequent the woods around Paris, to observe and study natural objects. His first scientific paper was published when he was seventeen years old, in the "Magasin de Zoölogie," and was an account of a new species of Souï, the *Cinnyris Adalberti*. His attention was directed at

* Any one possessing a reasonable knowledge of the general principles of evolution will easily see that the above views as to the lines of future progress are merely corollaries to the general doctrines of social evolution. Every social activity, like every individual habit, passes from the stage where it is the act of the whole organism to that wherein it is specialized and automatic. Every function soon evolves its special structure; and this structure, under normal conditions, automatically draws its nutrition in proportion to its expenditure in the service of the organism. This process is inevitable because it results in a saving of force, and an increase of active power supporting the organism, *as an act by a part is less costly than an act by the whole.* Increased heterogeneity and coherence in general evolution mean, in sociology, increased individualism and free association on lines of spontaneous attraction—that is to say, social evolution consists in a change from socialism to what we call individualism. The recent noisy reaction should not blind us to the great facts of the history of civilization, which is one long record of the decline of the *régime* of status in favor of that of voluntary association.

an early period of his investigations to animals which had been somewhat neglected by naturalists, and the fruit of his studies among them appeared in his work upon "Myriapods and Fresh-Water Polypi." In this work he defined accurately for the first time the characteristics of the animals, and followed out some of the changes which are gone through by certain of the species at various ages. In 1835 M. Gervais was admitted as preparator into the laboratory of comparative anatomy of the Museum of Natural History, and a special direction was given to his studies. Professor de Blainville was preparing a grand work on the bony frame of living and fossil mammals; and the young naturalist, exerting his whole effort in assisting his master, attached himself with marked preference to researches on extinct species, of which he had the satisfaction of describing definitely not a few that had been hitherto unobserved or inadequately studied.

In 1841, according to Larousse's "Dictionnaire Universelle," after having spent ten years in the Museum, according to M. Blanchard, M. Gervais was called to the chair of Zoölogy in the Faculty of Sciences at Montpellier, where he successfully continued his researches; and here he prepared and published his great book on the living and fossil vertebrates of France ("Zoölogie et Paleontologie Françaises," 1841–'52), which was regarded as in continuation of Cuvier's and Blainville's publications on the same subject. He became Dean of the Faculty in 1856; was chosen correspondent of the Institute; and, on the death of Gratiolet, in 1865, became his successor as Professor of Anatomy, Comparative Physiology, and Geology, in the Sorbonne. In 1868 he became Professor of Comparative Anatomy in the Museum of Natural History, "returning as master to the laboratory in which his early youth had been spent." In the collections of this institution he found subjects of a most interesting character which were still awaiting an historian; and applying himself to the tasks thus pointed out to him, he engaged in those researches which resulted in the publication of his excellent work on the fossil mammalia of South America. The remains of aquatic mammalia that lived in the ancient seas having been exhumed in enormous quantities, M. Blanchard continues, a general study of the *Cetaceæ* seemed to impose itself upon him as indispensable to the progress of an essential part of zoölogy. M. Gervais undertook this long and difficult study in co-operation with his friend Professor Van Beneden, of the University of Louvain, and after several years the fruit of their conjoint studies appeared as the "Osteography of Living and Fossil Cetaceans" ("Osteographie des Cétacés Vivants et Fossils").

M. Stanislas Meunier has given, in "La Nature," careful accounts of M. Gervais's principal writings, with estimates of their scope and value. The "Documents pour servir à la Monographie des Chiroptères Sud-Américains" ("Documents in aid of the Monography of the South-American Chiropteræ") included descriptions of many species which were entirely new. This was followed by numerous accounts of mammals, birds, and reptiles, which were largely inspired by the study of the specimens which Alcide de Orbigny, Eydoux, Soleyet, Castelnaud, and other travelers brought back from their long voyages. The examination of the series of birds led him to general conclusions respecting their natural division. These conclusions, drawn from the character of the skeleton, and particularly of the sternum, have been widely accepted. He interested himself in the study of the geographical distribution and classification of reptiles, in the course of which he made various investigations upon the batrachians, particularly the salamanders and tritons. In connection with his researches in the fishes, he was in charge for twenty years of the administration's experiments in pisciculture in the department of Hérault, the chief object of which was to acclimatize the true salmon, species which were not known to exist in any of the streams emptying into the Mediterranean. In co-operation with M. Walckenaer, he prepared a "Natural History of Wingless Insects" ("Histoire naturelle des Insectes aptères").

M. Gervais's first work in paleontology was the thesis which he prepared for the degree of Doctor in Science, on fossil birds. In it he demonstrated the existence, in the Tertiary period, of birds belonging to several genera common in the present age. Cuvier had proceeded in this line of investigation hardly further than to give approximately the order, and in only a few cases the possible genus to which his specimens might belong. M. Gervais, having better material at his command, was able to make more precise determinations.

In fossil mammalia he made known a new simian, the *Semnopithecus monspessulanus*, a hyena, several deer, a porcupine, and numerous cetaceans. His memoir on the distribution of the fossil mammalia among the several Tertiary beds of France deserves particular mention. It exhibited the association of the different species among the various faunas that succeeded one another, from the earliest Tertiary epoch, corresponding with the lignites of the Soissonais to the period of the large animals whose remains are found in the breccia of the caverns. The author shows that these different faunas, which he makes to number seven, never lived simultaneously, either in France or any other country, and that no species was common to more than one of them. The fauna which left its bones in the breccia is the only one which is not entirely extinct. Some of these faunas present only animals of terrestrial species, while others furnished in some of the beds both marine and land species. This feature gave useful indications for determining by the comparison of the land species buried in the marine beds with those which are found at other places in fresh-water deposits, the contemporaneity of land and marine animals for each epoch. It also enabled M. Gervais to determine, under certain conditions, the comparative age of the two kinds of formations. Contrary to the opinion of some paleontologists, the author showed that real cetaceans were not yet known in the deposits anterior to the Miocene. To M. Gervais are owing, in the study of fossil reptiles, some valuable observations on the footprints of the large batrachians called *cheirotherium* in the Triassic sandstones of Lodève.

Most of M. Gervais's publications were both zoölogical and paleontological. Some were of a more general character. Among these was the "Medical Zoölogy" ("Zoölogie Médicale"), which was published conjointly by him and M. Van Beneden in 1850, and is remarkable for the prominence given to the lower animals and to the theory of parasitism which is developed in it; and a natural history of the mammalia ("Histoire Naturelle des Mammifères"), 1855, in which attention is given to the habits of animals, and to their relations to the arts, commerce, and agriculture. This work, which is in two volumes, abounds in original observations, the fruit of the personal researches of the author, which have in many instances modified the views previously held by mammalogists. He was also the author of "A Theory of the Human Skeleton" ("Théorie du squelette Humain"), 1856; of the "Metamorphosis of Organisms and Alternating Generations" ("De la Metamorphose des Organisms et des Générations Alternantes"), 1861; on the "Antiquity of Man" ("De l'Ancienneté de l'Homme"), 1863; of "Elements of the Natural Scienees" ("Éléments des Sciences naturelle"), 1856; and of many notes, memoirs, and articles in the "Dictionary of the Natural Sciences," "Patria," "A Million Facts," "The Jardin des Plantes," and "La Nature." The wide range of subjects covered in these books testifies to the extent of his knowledge and the diversity of his talents. "In a science prodigiously vast," says M. Blanchard, "he showed himself familiar with most of the subjects, and was accounted among the most erudite." M. Gervais was elected to the Academy of Sciences in January, 1864, and with this he gained one of the great objects of his ambition. After working for nearly forty-five years, to the great profit and advantage of science, he died, from an illness of several months' duration, as poor as he had been in the earlier days of his career.

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Mr. J. G. Ellis has criticised, in the "Educational Weekly," Dr. Wilson's theory that a new American race is to be produced by the absorption of the Indian race with the white. Admitting, he reasons, that the white American race is acquiring peculiar characteristics, and that these are not unlike those of the Indian, may it not be the work of the American environment, rather than that of intercrossing with Indians, of which there is no sufficient evidence, but which is contradicted by indisputable genealogies in some cases where the approach to likeness is apparent? Sir Charles Dilke asserted, in his "Greater Britain," that the white American race was growing like the red Indian. The assertion seemed broad and strong, but something of the kind seems to be indicated in this discussion.

# CORRESPONDENCE.

### *MEN'S AND WOMEN'S BRAINS.*

An answer to Miss Helen H. Gardener and the "Twenty of the Leading Brain-Anatomists, Microscopists, and Physicians of New York."

*Editor Popular Science Monthly:*

Dear Sir: In the June number of the "Monthly" I find a communication entitled "Sex and Brain-Weight," signed Helen H. Gardener, and indorsed, as she says, by "twenty of the leading brain-anatomists, microscopists, and physicians of New York," which assumes to be in some measure a reply to my paper, in the April number, on "Brain-Forcing in Childhood." The tone of the letter is so bad, and it is written in so unscientific a spirit, that I have hesitated whether or not to notice it with an answer. But, lest silence should be held by some to imply that the assertions of the writer of the letter in question are entitled to weight, I have thought it better to ask the indulgence of a little space in your columns. I will premise by saying that I have no disposition to enter into a controversy on a subject that is at present, so far as I am concerned, of altogether secondary importance to the one to which my paper on "Brain-Forcing in Childhood" mainly relates, and that I shall not again in the present connection ask any similar favor at your hands.

With Miss Gardener's opinions of my antagonism to the female sex I shall not stop to argue. I have only to say that no one is more in favor than myself of woman's intellectual advancement, and that in all that I have said or done in recent years in relation to this subject I have recognized the natural equality of woman's brain with that of a man so far as mentality as a whole is concerned. I have only contended that her brain is different from that of man, and that *a fortiori* her mind must also be different. I am in favor of "girls and women" using all the means of development of which they can avail themselves, and which are of such a character as to fit them for the duties of their sex. I am very sure that in many respects—as, for instance, in the study of music, of painting, sculpture, literature, and many of the sciences—their opportunities are as great as those of men, and I regret that they have not made better use of them. I am opposed to their study of military science, or of such branches of knowledge as they are not likely to use in their lives, as a mere system of routine, just as I am opposed to similar procedures in boys.

Quoting from my paper, I repeat, "The skull of the male of the human species is of greater capacity than that of the female, and it is a singular fact that the difference in favor of the male increases with civilization."

Now let me bring forward some of the authorities for this statement in order that Miss Gardener may submit them to the "twenty of the leading brain-anatomists, microscopists, and physicians of New York," whoever they may be, who appear to have as little knowledge of the subject as she has herself.

I may say that there is no authority known to anthropologists that denies that the capacity of the average male skull is greater than that of the female. Miss Gardener and the "twenty leading brain-anatomists," etc., have only to refer to the "Revue d'Anthropologie," tome ii, series 1873, No. 3, page 481, for citations on this point in regard to twenty six different nationalities, and in every one of them the difference is marked. Relative to the second assertion, that the difference is greater in the civilized than in the uncivilized nations, I find in that table that Huschke determined that in twenty-one German men the average capacity of the cranium was 1,538·76 cubic centimetres, while the average in eighteen German women was but 1,265·23 cubic centimetres, showing a difference of 273·53 cubic centimetres in favor of the male skull. In twenty-one male English skulls, Barnard Davis found the average capacity to be 1,595·33 cubic centimetres, while in eighteen female English skulls it was only 1,372·54 cubic centimetres, a difference in favor of the male skull of 272·79 cubic centimetres.

Looking now at the lower races, we see that Barnard Davis, in twelve male Australian skulls, found the average capacity to be 1,316·85 cubic centimetres, while in the skulls of three Australian women the average was 1,273.08 cubic centimetres, a difference of only 43·77 cubic centimetres. In nine male negroes of Dahomey, he found the average skull capacity to be 1,493·88 cubic centimetres, and of three female negroes 1,412·33 cubic centimetres, a difference of 81·55 cubic centimetres. I could easily quote other figures to a like effect, but the foregoing are sufficient to establish the correctness of my assertion. If Miss Gardener and the "twenty leading brain-anatomists," etc., desire further information on this point, I would refer them to the "Dei Carateri Sessuali del Cranio Umano," by Paolo Mantegazza, published in the "Archivio per l'Anthropologia," vol. ii, 1872, or to the elaborate critical review thereof by M. A. Dureau, in the journal which I have already mentioned.

Miss Gardener appears to have looked into a copy of Topinard's "Anthropology," and perhaps the "twenty leading brain-anatomists," etc., have done likewise, though that is doubtful. In any event, let her and them turn to page 145 of the English edition, and they will find the following words:

"The head of the woman is smaller and lighter, its contours more delicate, the surfaces smoother, the ridges and processes not so marked. The superciliary arches are but little prominent; the external half of the superior orbital border is thin and sharp (Broca). The forehead is vertical below, projecting above. The occipital condyles are small, as also the mastoid and styloid processes. The zygomatic arches are slender. The cranium in its *ensemble* is less high and longer," etc.

Some of these differences are absolutely inseparable from corresponding differences in the form of the brain.

Then, if they will refer to Carl Vogt's "Lectures on Man," page 90, they will find the differences between the male and female crania, due to civilization and barbarism, stated to the same effect as I have given them—that is, that they are more marked between the sexes in the civilized than in the uncivilized nations.

Now, in regard to the cause of this condition, Miss Gardener says that I "hold it to be a natural and unalterable difference in the brain-mass itself!" How she came to venture upon this assertion is a mystery to me, and I can only attribute it to that defective logical power which appears, for the present at least, to be a characteristic of most female minds. So far from saying anything of the kind, I offered two entirely different explanations of its cause: one to the effect that civilized women had not availed themselves of the advantages offered them, and hence had not developed their brains *pari passu* with those of men; or else that the work of barbarous men being very similar to that of their women, there had not existed the same necessity for an increased development of their brains.

Then Miss Gardener, without any notice to the reader that she has changed her source of information relative to my views, proceeds to quote from a paper of mine written several years ago, on the subject of "Women in Politics." To be sure, she mentions previously that she intends to quote from two of my papers; but no one reading her letter could believe otherwise than that she was citing extracts from the paper on "Brain-Forcing in Childhood," published in "The Popular Science Monthly" of April last. I have no copy of the other paper before me, it having been published in the "North American Review" several years ago; but doubtless she gives the words correctly, and I state them here with her comments as I find them in her letter:

"Dr. Hammond asserts, again, 'It is only necessary to compare an average male with an average female brain *to perceive at once how numerous and striking are the differences existing between them*' (the italics are mine). He submits a formidable list of striking differences, which include these: 'The male brain is larger, its vertical and transverse diameters are greater proportionally, *its shape is quite* different, the convolutions are more intricate, the sulci deeper, the secondary fissures more numerous, the gray matter of the corresponding parts of the brain decidedly thicker'; of this latter part the doctor modestly says that 'the evidence is not so full as might be desired.' But, as if all these were not quite enough to enable the merest novice to distinguish a male from a female brain, he offers these re-enforcements: 'It is *quite certain*, as the observations of the writer show, that the specific gravity of both the white and gray substances of the human brain is greater in man than in woman.'"

From this last remark she proceeds to draw the inference (in which doubtless she is sustained by the "twenty leading brain-anatomists," etc.) that the greater prevalence of insanity among men than women is the result of the greater specific gravity of the brain, forgetting that the life of man is so much more active than that of woman, his liability to injuries so much greater, his addiction to the excessive use of alcohol so much more common, and his habits generally so much worse, as to constitute the real reasons why he is more liable than woman to become insane.

Moreover, she appears to be entirely ignorant of the facts, as are likewise doubtless the "twenty leading brain-anatomists," etc., that the specific gravity of the brain is increased in insane women as well as in insane men, and that, instead of being a cause, it is probably a consequence of the morbid processes to which the brain of the insane is subjected.

But, in regard to the description which I have given of the average female brain, I stand ready to prove its correctness, not, however, in the rough-and-tumble fashion proposed by Miss Gardener, but by a process by which all such determinations are made by those who know what they are about.

Suppose, for instance, I am describing a woman's thumb, and pointing out its differences from that of a man. I should say that it was shorter, smaller in circumference, that its articulations were not so prominent, that the processes on the bones for the attachments of muscles were not so well marked, that its muscular structure was more delicate, that the skin was softer, and finer, and freer from wrinkles, that the nail was longer in proportion to its width than that of man. Such would be the description of an average female thumb, as I see thumbs belonging to the ladies of my acquaintance.

Now, following Miss Gardener in the offer which she makes, and according to which—by my ability to select rightly in every instance—I am to gain or lose my case, I make this proposition to her :

I will agree to furnish twenty well-preserved thumbs, marked in cipher, if subjects can be obtained for the experiment, Miss Gardener or her "twenty leading brain-anatomists," etc., to divide the male from the female thumbs, by applying any knowledge they may possess on the subject.

Doubtless Miss Gardener and the "twenty leading brain-anatomists," etc., know a male from a female thumb when they see them, but I am quite sure that by judicious selection, I should be able to confound their judgment. I should take some of the male thumbs from small, delicate men who had never done any hard work, and who had taken good care of their hands by wearing gloves and availing themselves of the services of a manicure, while I should select some female thumbs from women whose hands are hardened and enlarged by exposure and toil, and to whom nail-brushes and soap-and-water are rarities. I am quite safe in saying that Miss Gardener and the "twenty leading brain-anatomists," etc., would find it impossible to select the ten male from the ten female thumbs, and I am equally certain that there is not an anatomist of the brain kind, or any other variety, who could accomplish the feat.

That there are female brains that are larger than male brains, of altogether superior development, and the possessors of which have greater intellectual power than is exhibited by some men, neither I nor any any one else, so far as I know, has ever denied. Miss Gardener can not be in ignorance of my views on this subject, for she quotes my words "average male and average female brain," and it is to the "average" female brain only that my description applies. A fair proposition would be the following, and, if Miss Gardener, from the resources at her command—"the collections" of the "twenty leading brain-anatomists," etc.—will supply the brains, I will agree to stand or fall by the result. Weigh one hundred male brains and then one hundred female brains: if the average weight of the male brains is not several ounces greater than that of the female brains, I lose my case. The only condition I make is that I shall be present when the brains are selected and weighed.

It is scarcely necessary, however, to repeat an experiment that has been performed by many anatomists in all parts of the civilized world. Thus, Welcker's observations show that the average male brain in Europeans is a little over forty-nine ounces, and the average female brain a little over forty-four ounces, a difference of about five ounces. The proportion existing between the two is therefore as 100:90. Huschke found the brains of adult man and woman to weigh respectively 1,410 grammes and 1,272 grammes. His observations, therefore, coincide very exactly with those of Welcker.

Calori not only found that the brain of man is heavier than that of woman, but he discovered the fact that the difference exists no matter what may be the form of the skull. Thus in men with brachycephalic skulls, the average weight of the brain was 1,305 grammes, while in brachycephalic women it was only 1,150 grammes. In the dolicocephali the average weight of the male brain was 1,282 grammes, whereas that of the female brain was 1,136 grammes.

Broca, in his paper "Sur le volume et la forme du cerveau," arranges from Wagner's elaborate table one which shows that this difference exists for all ages from twenty-one years to sixty and over. The results are given in grammes in the following table :

| AGE. | MEAN WEIGHT OF BRAIN. | |
|---|---|---|
| | Men. | Women. |
| From 21 to 30 years.... | 1,341·53 | 1,249 |
| From 31 to 40 years.... | 1,410·36 | 1,262 |
| From 41 to 50 years.... | 1,391·41 | 1,261 |
| From 51 to 60 years.... | 1,341·19 | 1,236·13 |
| From 61 upward....... | 1,326·21 | 1,208·43 |

In fact, all authorities, without exception, save Miss Gardener and the "twenty leading brain-anatomists," etc., agree that the average European male brain is about five ounces heavier than the average female brain.

Another test that I am willing to abide by is the following, relating to the other characteristics that Miss Gardener quotes as having been laid down by me:

Let her, from the stores at her command, allow me to select from at least one hundred specimens an average female brain, and from a like number an average male brain. I will agree to point out to a competent brain-anatomist—not one of the "twenty," however—all the differences for which I have ever contended. By that test also I am willing to stand or fall.

I have never said, as Miss Gardener charges, that the sex of an infant could be determined by its brain, though Rüdinger declares that a typical point of difference between the male and the female brain can often be found at the seventh or eighth month of foetal life, and that the male has the frontal lobe better developed than has the female, and that there is an earlier development of the secondary fissures in it, and in the parietal lobe.

I commend this matter to the serious consideration of the "twenty leading brain-anatomists," etc. I scarcely believe that any one of them, without reference to the "physical sex differences" referred to by Miss Gardener, could tell the sex of a three-months-old infant by a minute inspection of all the rest of its body.

A word more in relation to the subject of the comparative weight of the brain in the two sexes. Miss Gardener and, presumably, the "twenty leading brain-anatomists," etc., deny that there is any superiority of brain-weight in the man over that of woman, and she instances the fact that the difference in the weight of some men's brains is greater than that existing between that of the sexes. No one questions that matter, so far as I know, but certainly nothing of any importance to her case is to be drawn from the fact. A like condition exists in regard to almost all parts of the body. Thus the average foot of a woman is smaller than the average foot of a man, yet the difference between the feet of some men is greater than the average difference between the foot of man and woman. The average ear of a man is larger than the average ear of a woman. Yet some women have prodigious ears, far exceeding in size the ears of some men; it would certainly not be correct to assume from these facts that a woman's foot or a woman's ear is larger than the corresponding members in man. It is with averages deduced from a large number of observations that we have to deal in matters of this kind and not with individual examples.

Dr. Thurnam gives the average brain-weight of ten men who were remarkable for their intellectual development as 54·7 ounces, among them that of Cuvier, 64·5 ounces; Abercrombie, 63 ounces; Spurzheim, 55·6 ounces; Daniel Webster, 53·5 ounces; Lord Campbell, 53·5 ounces, and Chalmers, 53 ounces. Now, let Miss Gardener and the "twenty leading brain-anatomists," etc., search the records of anthropology and their own immense collections for the brain of a woman weighing as much as the least of these, that of Dr. Chalmers. I venture to say that there has never been in the history of the whole world a female brain, free from obvious disease, weighing more than fifty-six ounces, whereas there have been many male brains exceeding this by several ounces.

Next, in regard to the relative and absolute brain-weights in the two sexes and in animals generally, Miss Gardener shows that she is ignorant of the points involved. She quotes me as saying, "Numerous observations show beyond doubt that the intellectual power does not depend upon the weight of the brain *relative to that of the body* so much as it does upon *absolute brain-weight.*" (The italics are Miss Gardener's, who, not content with exercising the feminine proclivity of italicizing what she writes, takes that liberty to no small degree with what I have written.) This is true, but she does not understand in what its truth constists, for she goes on to assert that in accordance with its dictum the brains of the whale and of the elephant, being of vastly greater weight than the brain of man, the animals possessing them should be superior to man in intelligence. Here she very disingenuously or very ignorantly attempts to make it appear that I have declared absol te brain-weight, regardless of species and genera, and without reference to the structure of the organ, to be the test of intelligence; whereas, in everything that I have ever written with reference to this point, I have invariably expressed the diametrically opposite opinion. But, if the brain of a whale or that of an elephant had as large an amount of gray tissue and as complex a structure as that of man, it is very certain that *then* the whale and the elephant would stand at the head of all animated nature, and that man would be their slave. "The elephant, which disports himself for the amusement of small boys and the enrichment of Mr. Barnum," would be quite capable of causing the small boy and Mr. Barnum to amble, and gyrate, and to stand on their heads for his—the elephant's—amusement and that of his wife and children. It is not only in size that the male brain differs from that of woman, but that its structure and arrangement are also different.

The *absolute* brain-weight is, therefore, of little consequence, except when it relates to animals of the same species. A whale, with a brain weighing six or seven pounds, would be a more intelligent whale than one with a brain of four or five pounds. A man with a brain weighing sixty-five ounces is potentially a more intellectual man than the one with a brain of thirty-five ounces. In three individuals of very feeble intelligence Tiedemann found the weights of their brains to be 19¾, 25¾, and 22½ ounces, respectively. Mr. Gore has reported the case of a woman, forty-two years of age, whose intellect was infantine, who could only speak a few words, whose gait was unsteady, and whose chief occupation was carrying and nursing a doll. After death the weight of her brain was found to be but ten ounces and five grains.

As to relative brain-weight, I do not attach much importance to it, as it is subject to variation according as the individual increases or diminishes in weight. Thus, if a man or a woman weighing one hundred and fifty pounds has a brain weighing three pounds the proportion of brain-weight to body-weight is as 1 : 50. But, suppose the person loses fifteen pounds in weight, then the proportion becomes 1 : 45, whereas if there should be a gain of a like amount the proportion would change to 1 : 55. In the first instance, if relative weight has anything to do with intelligence the mental power would be increased, while in the other case it would be diminished. Of course, no such change takes place.

Many years ago I made several thousand observations in regard to the weight and other qualities of the brains of various species of animals belonging to the classes of reptiles, fish, birds, and mammals. In these investigations I went over to a great extent the ground previously traversed by Leuret, and in some respects made new observations. I found among other interesting facts that the brain of the canary-bird, reared in the United States, was in weight as compared to the body as 1 : 10·5, and in the Arctic sparrow as 1 : 11. These little animals have the largest brains relative to the body of any others yet examined. To pretend that they are superior in intelligence to man, in whom the weight of the brain relative to that of the body averages 1 : 36·50, is, of course, ridiculous. Yet that is the conclusion to which Miss Gardener, and presumably the "twenty leading brain-anatomists," etc., would have us come.

Broca declares that the difference in weight between the brain of woman and that of man is not due alone to the smaller size of her body, but to the additional fact that woman is in the mean, when compared to man, a little less intelligent; a fact, he says, which should not be exaggerated, but which is nevertheless real. This is going somewhat farther than I have ever gone, but what Broca says in a matter of anthropology is worthy of serious attention.

When Miss Gardener says that I make relative difference "count for a great deal" when existing between two men, she passes the limits of correctness. I have never said anything of the kind.

One more point, and I have done. I stated, in the paper on "Brain-Forcing in Childhood," that the human head does not grow after the seventh year, and Miss Gardener, with the assistance of the "foremost brain-anatomist of New York," is quite facetious over the assertion. Instead of *head* I should have said *brain*, and then the point involved would have been more correctly stated; for the scalp, muscles, fasciæ, etc., of the head have nothing to do with the issue which concerns the mind only as derived from the brain. In regard to the growth of the brain in size and weight, there is abundant authority for the statement that it ceases to advance at or about the seventh year. Soemmering states that the maximum is attained at three years. The brothers Wenzel, at between six and seven years; and Tiedemann, at between seven and eight years. Other observers have arrived at different results, but there is room for a difference of opinion on the subject, and Miss Gardener should have been aware of the fact when she dismissed the statement as though it were entirely unauthorized.

That the brain ceases to grow at a comparatively early age is abundantly established by the observations of several competent brain-anatomists. Thus, Dr. Boyd, who based his conclusions on the examination of over two thousand brains, found the average weight to be, at the age of from ten to twenty, 48·5 ounces—the maximum weight for all ages, and four ounces heavier than in persons whose ages ranged from twenty to thirty.

Broca, quoting from Wagner's tables, gives the mean weight in persons of from ten to twenty years as 51·7 ounces—heavier by 4·4 ounces than in persons from twenty to forty years of age.

The average weight of the brain in forty-seven persons of English, Scotch, and German nationality, as given by Thurnam in one of his tables, is 49·6 ounces in those whose ages range from ten to twenty years —a weight considerably in excess of that shown for any other period of life.

The general truth of the assertion made in my paper on "Brain-Forcing in Childhood," that "the brain of a child is larger in proportion to its body than that of the adult" is, therefore, not only established, but the additional fact inferentially stated, that the brain is absolutely larger in childhood than in adults, is shown to be correct.

And now I must bring this communication to a close, feeling that I have given more attention to Miss Gardener than she and the "twenty leading brain-anatomists, microscopists, and physicians of New York" deserve, and advising them that before they again rush into print they make themselves to some extent acquainted with the elementary truths of the science of anthropology.

William A. Hammond.

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THE EXPLOSION AT BRIGHTON, ILLINOIS.

*Editor Popular Science Monthly:*

Sir: The letter of Mr. A. O. Fay, published in No. 182, seems to call for a few words in reply, for Mr. Fay appears to have mistaken the purpose of the article to which he refers. In the first place, the entire aim of my article in No. 180 was to present the phenomena connected with the explosion of August 29, 1886, and not, as Mr. Fay seems to think, to generalize from a single phenomenon, nor to denounce the methods of building magazines at present adopted. A careful re-reading of the article in question, in the light of Mr. Fay's letter, fails to reveal any such denunciation, or illegitimate generalization.

In reference to the proper construction of powder-magazines, your correspondent clearly condemns the method adopted at Brighton, as shown in the three magazines personally examined, and which I was informed, by the agent in charge of one whose walls were injured in the explosion, was the plan of all. In this, of course, my source of information may have been at fault. But there is not one word in my article which can be tortured into a condemnation of this form of construction, though I did say that "a recent occurrence dangerously near Chicago has shown that it is by no means sufficient" as a matter of protection, and the town of Lake took a similar view. What I did characterize as *very strange* is the omission of any protection against lightning, and I may add that one of this same group of magazines was destroyed by lightning before, I think in 1879, though I have not the date at hand.

Then Mr. Fay says that "the simplest knowledge of the properties of dynamite would have prevented Professor Griffin from attributing the non-explosion of other magazines in the vicinity to the fact of their being beyond the *limits where displacement would not appear*." The words italicized are quoted in a garbled form, which gives them a very different meaning. Originally, they stood as parts of two sentences. This is an easy way of avoiding an explanation of the phenomena. My article suggests an explanation, does not give it as the only explanation; but there were the phenomena, and to deny my explanation, without any suggestion of another, is a good illustration of the method of destructive criticism now so popular: why does not Mr. Fay give his own explanation? Facts are sometimes stubborn things; and the circle of magazines and other buildings uninjured while those nearer the wrecked magazine were destroyed and those farther off were wrecked, is a fact.

I am very glad to be informed of my ignorance of the fact that other substances have taken the place of infusorial earth in the manufacture of dynamite; it would have been more gratifying had Mr. Fay told us what those substances are—or is it now a "trade secret"? But I am at a loss to understand what he can mean by his statement that "it would practically be impossible to find offered for sale by any manufacturer or dealer any dynamite, in the compounding of which earth or any other inert matter had been used." Does dynamite, as now made, contain some substance that reacts chemically upon the nitro-glycerine? If so, the public would undoubtedly be glad to know it, as the danger in the storage of the substance is probably increased thereby.

Mr. Fay's method of quoting parts of sentences and making them appear as used in reference to different points from those to which they were applied does not seem to me quite fair. Yours truly,

La Roy F. Griffin.

Lake Forest, Illinois, *June* 8, 1887.

# EDITOR'S TABLE.

### *SCIENTIFIC ORTHODOXY.*

ONE of the accusations brought by the Duke of Argyll against Professor Huxley in the discussion that lately took place between these two representatives of very different lines of thought was—to put it plainly—that the professor was himself half in rebellion against a kind of scientific orthodoxy that has been established in these later days, and was only waiting until the movement against it now going on among the younger men of science had gathered a little more strength, in order to declare himself. The professor warmly, and with good reason, repelled the implied charge of insincerity, and asked what were the signs or proofs on any such scientific tyranny as his Grace referred to. He had himself a pretty wide acquaintance with scientific men, young and old, and if they were under any constraint that prevented them from uttering their opinions and conclusions with the utmost freedom, he was not aware of it. There was really no foundation, we may safely aver, for the duke's taunt as regards men in the higher walks of science. These pursue their researches with no object save that of the advancement of scientific knowledge. They give their facts to the world just as they present themselves. If there is anything a scientific man labors to be exact in it is in the description of what he has observed. He knows that, if he is inaccurate here, some one will go over his work and discover and expose his errors, thus destroying in a large measure the credit he might otherwise reap from his arduous investigations. No; there can be no question that men of science give the world pure facts as far as they are able; probably no men, not even the clergy, work under so deep and constant a sense of responsibility for the exhibition of the truth without any admixture of fable.

The weaving of facts into theories is, however, another matter, and here undoubtedly a certain personal element may come into play. When Darwin's theories were first broached, all the world, nearly, cried out against them. They were demolished a countless number of times, not only in theological but in scientific periodicals. The world was under the influence of the special-creation hypothesis, and the facts and reasonings of Darwin fell far short, even in the minds of the most of those who read his work, of shaking their faith in the old system of thought. The seed sown was not, however, trampled out of existence, as it might have been in an earlier age. It took lodgment in some minds, and it was not long in showing that it possessed a strong principle of vitality. To-day evolution, in a wider sense than Darwin himself was at first prepared for, is the dominant philosophy. No doubt it was to this philosophy that the duke referred when he hinted at the existence of a kind of intellectual tyranny in the world of scientific thought. It may be, of course, that just as evolution was opposed in the past on account of its novelty and its disagreement with accepted theories, so, now that it has gained a certain prestige, it may receive the adhesion of some who like to be on what appears to be the stronger side, and who may support it in the spirit of partisanship rather than of conviction. How this is to be avoided, while human nature remains what it is, it is difficult to see. Every school of thought that ever existed in the world has had, in addition to its reasonable and convinced adherents, other adherents, in whom the spirit of sect and party has been much stronger than the love of truth. But while we may admit that the evolution philosophy has not escaped, and is not likely to escape, the fate of philosophies in general in this respect, we may very confidently assert that no one to-day who is capable of making any original investigations that might have a bearing on the doctrine of evolution is in the least likely to be unduly influenced by any weight of authority on the side of any particular theory. There never was an age when, in matters scientific and philosophical, there was so complete a "liberty of prophesying" as there is to-day. To talk, therefore, of "scientific orthodoxy," as some do, with the intention of suggesting a parallel with theological orthodoxy, is altogether unfair and misleading. There are no courts for the trial of scientific heresy. The only penalty any man incurs for putting forth inaccurate statements of fact or inconclusive reasonings is that, upon the exposure of his errors, his scientific standing is more or less compromised according to the gravity of the case. No scientific worker can be condemned by the mere *ipse dixit* of any authority however distinguished: the appeal to facts lies open to the humblest citizen in the republic of science. Here truth is Cæsar, and there is no divided empire.

But, while Science does not set up any unalterable code of opinion, while it does not seek to withdraw any theory or hypothesis whatsoever from the control of verification, it has its own way of looking at things, its own methods of testing what is proposed for acceptance; and in the application of these methods it shows a rigor which, by ill-prepared minds, might be mistaken for dogmatism. It insists upon an exact definition or delimitation, so to speak, of the object to be considered. "*What* are we talking about?" is a question always in order. It declines to have any dealings with things that are in their nature inaccessible to observation. It refuses to convert sentiments into convictions, or to build assurance upon doubtful analogical inference. It insists upon stopping short just where the facts stop short, and where, therefore, further verification fails. It shuns the dead-reckoning of metaphysical argumentation, and is no less guarded in its denials than in its affirmations. What it can not disprove it will not deny, any more than it will affirm what it can not prove. But if, because a statement or theory can not be disproved, any one wishes to claim that it is proved, Science protests, just as it would do if one were to pretend that, because a thing can not be proved, it is disproved. On every occasion Science says, "Let us take an exact measure of the facts, and let our words conform thereto." It is this severely truthful attitude which draws down upon men of science so much disfavor in certain quarters. If the scientist would only be a trifle accommodating, and where he sees but little would consent to believe much; if he would only accept the currency of confused thoughts and indeterminate expressions; if he would administer metaphysical comfort instead of constantly pointing to the unalterable and demonstrable conditions of human life—he would be more popular with the unthinking multitude, and even with some would-be leaders of thought. But the scientist knows that, if there is any solidity in the edifice of science to-day, it is due to the firm attitude his predecessors, and in part his contemporaries, have maintained toward pleasing and popular errors—to their determination to see the truth, and to bear witness to it, and to nothing else. We may say, using the words in a certain accommodated sense, that "scientific orthodoxy" requires that this attitude shall be maintained. Not to take every possible means for the elimination of error would not be "orthodox" from a scientific point of view; but further than this we can scarcely go in the use of the term. There need be no fear that the progress of knowledge will be checked, or that originality of view will in any way be repressed. The world never had so splendid a generation of scientific workers as it has to-day; and never, as we have already said, was scientific work being done under less restraint, or less undue influence from any kind of personal authority.



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### PHYSICAL CULTURE AND MORAL REFORM.

It is impossible to read without intense interest of the experiments made in the New York State Reformatory to ascertain whether the moral and mental faculties of criminals might not be roused, and to some extent developed, by a judiciously arranged course of physical exercise. It appears, from the report furnished by Dr. H. D. Wey, that these experiments have been attended with marked success: mental growth has been promoted, and moral control has been increased as a direct result of the physical training administered. Accepting these statements as correct, as we are quite prepared to do, we see vast possibilities opened up of moral reform among a class of the population whose deficiencies have hitherto been the despair of philanthropists and philosophers. The true spirit of humanity was probably never stronger in any man than in Tom Hood; and yet even he was disposed to leave criminals to their own darkened intelligences and evil dispositions.

"'Tis sorry writing on a greasy slate,"

he says in his address to Mrs. Fry, the benevolent Quaker lady who interested herself so deeply in the inmates of jails and penitentiaries. He admired many things about that amiable lady. "I like," he says—

"Your dove-like habits and your silent preaching;
But I *don't* like your *Newgatcory* teaching."

"Nugatory" Tom thought it, and nugatory, indeed, the great mass of such teaching has been, as prison chaplains would themselves confess. But if it is the case that the energies of the mind and of the moral nature are sadly cramped and confined through imperfect physical development and abnormal physical habit, what may we not hope for if, by proper gymnastic exercise and sound sanitary conditions, we are able to remedy, to a great extent, these bodily defects? The idea that body and mind work together, and that it can not be well with the one if it is ill with the other, was a commonplace among the ancient Greeks; but for ages the truth was lost sight of, and was indeed supplanted by the antagonist error that if we would cultivate and develop the soul we must oppress and dishonor the body. We are now working back to the Greek point of view; and, with the exact methods of modern science to aid us, may be expected to turn whatever of truth it contains to better use than they did. The Greeks held, empirically, that rhythm of sound and rhythm of motion—particularly simple rhythms free from all *bravura*—had a regularizing effect upon the thoughts and a moderating effect upon the passions. Now, this is precisely what the average criminal nature most needs. The criminal is essentially a man who does not naturally act in unison or harmony with his fellow-men—he is prone to strike discordant notes—that is, to perform irregular and lawless actions. This disposition is probably due in part to distrust of himself, arising from a secret consciousness of deficiency. To such a man, a well-directed course of bodily exercise means, in the first place, the development of his physical organs and faculties; in the second place, a certain sense of power resulting therefrom; thirdly, a heightened self-respect and self-confidence; fourthly, a sense of the value of method; fifthly, a more regular flow of thought to more definite objects; and, sixthly, a certain development of the social instinct arising from a generally improved bodily and intellectual condition.

It may be accepted as a general principle that when a given result proves very difficult if not impossible of attainment we are trying to take *too big a step* to get at it—that is, we are overlooking some intermediate stage or stages that have to be passed through before we can get at our objective point. It is as if we wanted to get up-stairs all at once, instead of proceeding step by step. Well, in regard to criminals, we have preached at them in the effort to reach their spiritual nature; we have set the schoolmaster on them, in the effort to rouse their dormant intellectual faculties; now, at length, after abundant evidence as to how little either chaplain or schoolmaster can effect, we are trying what the drill-master can do to mend their crooked bodies, to reform their shambling gait, to fix the vacant or wandering eye, to infuse life, vigor, and "snap" into spiritless frames; and at last it seems as if we were on the right track. After all, what did St. Paul tell us long ago? "First that which is natural" (physical), "then that which is spiritual." Well, without heeding him any more than the ancient Greeks, who, in this matter at least, were so wise, we have in the main been working, or trying to work, on the spiritual, and leaving the natural to shift for itself, even when its defects have been most conspicuous, and when, owing to these defects, the spiritual has been almost non-existent. It is time to go back on our tracks and to see to it that we make things as right as we can in the natural region, before we look for intellectual results or the peaceable fruits of righteousness. We seem already to see Science, the despised Cinderella, as Huxley says, scoring another triumph, and showing that, even for moral reform, its methods are worth more than all other modes of activity put together.

## LITERARY NOTICES.

The Problem of Evil. An Introduction to the Practical Sciences. By Daniel Greenleaf Thompson, author of "A System of Psychology." London: Longmans, Green & Co. 1887. Cloth. 8vo. Pp. 281.

"The Problem of Evil," though modestly heralded by its author as "An Introduction to the Practical Sciences," and not assuming to present a complete exposition of ethical science, is in reality a noteworthy contribution to that department of philosophical inquiry. Aiming to clear the way for a popular understanding of the scientific method as applied to moral and social problems, Mr. Thompson's treatment of his topic is less technical and systematic than readers of "A System of Psychology" would naturally be led to expect. The present work, however, loses little, if anything, in value to the philosophical student on this account, while its more popular style, and the practical nature of many of the questions herein discussed, will doubtless render it more attractive to the general reader, and introduce its author to many new acquaintances among thinking people.

The question presented in the earlier chapters of this book, and ably discussed in all its various phases throughout the succeeding pages, is none other than the great problem of all the theologies and moral philosophies: How shall we interpret the startling but undeniable fact of moral evil? How may we most wisely strive for its abatement and cure?

After briefly and fairly stating the chief theological explanations of evil—"those which look to a supernatural source and cause"—and expressing his dissent from this method of approaching the subject, our author proceeds to define moral evil as "pain caused by human volition" (p. 17); and to investigate briefly its causes and offices in the human economy. "Pain," he concludes, "is a universal concomitant of mind, so far as we are able to make mind a subject of science." As we are unable to trace, scientifically, the origin of mind or life, we are therefore baffled in our attempt to disclose the ultimate origin of evil. The practical problem, accordingly, to which we should turn our attention is, How may we seek for its elimination by the most effectual means? In other words, How may we best strive for the advancement of human happiness?

Readers of "A System of Psychology" will be prepared to find our author in accord with utilitarian theories of ethics. The psychological and philosophical elements involved in the problem of evil, however, are assumed, or briefly sketched, rather than presented in the form of a complete argumentative exposition, in the present work—the philosophical foundations of this study having been laid by the author in the work before mentioned. From the standpoint of a rational utilitarianism, he criticises with great acuteness and force what he terms the "Æstho-Egoistic" philosophy of Thomas Hill Green, and other representatives of the intuitional school. In the "subjective feeling or consciousness of self-satisfaction," which expresses the *summum bonum* of intuitional ethics, he discovers an ideal which is essentially egoistic. His own interpretation of utilitarian ethics, on the other hand, issues in an altruism which is widely removed from the alleged "selfishness" of the hedonistic philosophers. The "Chief Ideal Good" being "the existence of all individuals without pain, presentative or representative, during this period of existence," right conduct is that which tends toward this ideal, and right volition is the will to act according to its requirements (p. 71).

The four chief methods of reducing evil are found to be—1. "The Control of Material Forces," through industrial effort and scientific discovery and investigation; 2. "Security and Justice," through political action; 3. "Direct Altruistic Effort"; and, 4. "The Development of Individual Character," through education and moral training. The chief hindrances to this work are—1. The artificial morality of supernatural theology; 2. The unwarranted elevation of institutions above the individual; 3. The notion that social ends are more perfectly realized through the concentration of power in organizations; and, finally, the formation and retention of egoistic ideals of life.

In the section on "The Great Theological Superstition," Mr. Thompson criticises unsparingly, but in no dogmatic tone, the theological doctrine of sin. The idea that there can be a sin against God other than a violation of the rights and happiness of individual men, is found to be untrue, immoral in its implications and results—one of the chief obstacles, indeed, to human progress. Man's "sin against God, if it exist, is in his sin against his fellows"; in other words, theological sin, *per se*, is a fiction of the imagination; the only reality which can answer in any way to this conception is natural moral evil. Incidentally Mr. Thompson condemns the laws against blasphemy, the exercise of temporal power by the Church, the Pharisaical self-righteousness which he conceives to be the outcome of theological supernaturalism, the "baleful dogma" of eternal punishment, and the mystical conception of "spirituality," as something other than simple goodness, stimulating men to altruistic endeavor.

In the section on "The Institutional Fetich," a rational individualism is maintained as a higher ethical ideal than that which sinks the individual in the mass, and emphasizes institutions at the expense of personal liberties. "Man is the measure of all things." Institutions are made for man, not man for institutions. Authority must give way to the right of private judgment. The doctrine that "the family, the state, the Church, exist superior to any considerations of utility," must be condemned as inimical to the highest development of human character, and as an obstacle to the moral advancement of the race. The principle of authority in the family has resulted in the degradation of woman and the ignoring of the rights of children. "The husband owes to the wife just as many duties as she to him." "Children are to be worked for as human beings having their own independent ends, which are to be respected." "The doctrine of authority has been from the beginning, and is to-day, a stumbling-block in the way of woman's liberty and advancement."—These sentences strike the key-note of Mr. Thompson's liberal and humane treatment of these important social problems, which we can only thus briefly outline within the limits of this review. The divine authority and perfect character of the state is of course condemned as an irrational dogma. The right to agitate against an existing social order is strenuously affirmed. "Any system which does not permit the title of a governing power to be questioned by the governed, in the light of what is best for the general happiness, is a system of rule by force and fear, disguise it as you may under high-sounding phrases, as 'inherent sacredness,' or 'divine authority.'"

Under the head of "The Socialistic Fallacy," the questions of the "Co-operative Idea," "Socialism," "The Political Party," "Industrial Co-operation," are treated with great clearness and in an admirable spirit, as the reader will agree, even if he does not find himself wholly in accord with our author's conclusions. He cries "Halt!" to the active socialistic tendencies of our time, believing that they must ultimate, if successful, in an increase of egoism and restriction of individual liberty, which would be fatal to the highest ethical advancement of the race. Not in individualism, but in egoism, he affirms, is to be found the most serious obstacle to our moral progress.

Finally, the root of existing moral evil is found in the continued elevation of the egoistic ideal as an incentive to human action. War and the militant system are condemned as outgrowths and perpetuators of this ideal. The injustices and immoralities of our industrial system are referred to the predominance of egoism in our industrial methods; and the relief for all these social evils is indicated in the two rules:

1. "Aim at the minimum of extrinsic restraint, and the maximum of liberty for the individual."

2. "Aim at the most complete and universal development of the altruistic character."

While Mr. Thompson is in general accord with the English utilitarian school of philosophy, he is evidently an independent and original thinker—no mere servile follower of sect or leader. In many respects his conclusions agree with those of Mr. Herbert Spencer; but he is no imitator of Mr. Spencer's style, and he does not hesitate to express a frank disagreement with his opinions upon occasion—as in the matter of state education, which Mr. Thompson advocates, while Mr. Spencer condemns. A multitude of the pressing problems of our social life are suggested and discussed in this compact volume, with such frankness, sincerity, ability, and good feeling, that we can heartily commend it not only to the professional scholar, but to all thoughtful men and women. The interest which it will awaken will doubtless bespeak far Mr. Thompson's larger work—"A System of Psychology"—a wider circle of readers than it has hitherto had in this country.

The Factors of Organic Evolution. By Herbert Spencer. New York: D. Appleton & Co. Pp. 76.

The two parts of which this essay consists were originally published in successive numbers of "The Nineteenth Century," and also of "The Popular Science Monthly." They are now given in a single volume, together with some passages of considerable length which were omitted, for the sake of brevity, from the magazine publication. Mr. Spencer believes that though mental phenomena of many kinds are explicable only as resulting from the natural selection of favorable variations there are others, still more numerous, which can not be explained otherwise than as the results of the inheritance of functionally-produced modifications. Not only the conceptions we form of the genesis and nature of our higher emotions and moral intuitions, but our sociological beliefs, are profoundly affected by the conclusions we draw on this point. "If a nation is modified *en masse* by transmission of the effects produced on the natures of its members by those modes of activity which its institutions and circumstances involve, then we must infer that such institutions and circumstances mold its members far more rapidly and comprehensively than they can do if the sole cause of adaptation to them is the more frequent survival of individuals who happen to have varied in favorable ways." Considering the effects which the acceptance of one or other of these hypotheses must have on our views, life, mind, morals, and politics, the question which of them is true, Mr. Spencer adds, "demands, beyond all other questions whatever, the attention of scientific men."

The Ruling Principle of Method applied to Education. By Antonio Rosmini Serbati. Translated by Mrs. William Grey. Boston: D. C. Heath & Co. Pp. 363. Price, $1.50.

Rosmini proposed to apply to education the principles which were independently worked out by Froebel into the Kindergarten—the principles, as the translator describes them, on which Nature herself works. He contemplated a complete treatise on pedagogy, to be worked out in departments corresponding with the several stages of the unfolding and building up of the pupil's mind, having in view, however, not only the child at school, but, to use the words of Francesco Paoli, "the adult and the old, the whole race, in short, because in the man, at every stage of life, there is something of the child; there is a new development going on within him, which requires to be guided and assisted that it may reach a successful issue, and the man learn to educate himself." With this view, he divided his subjects into periods computed by the degrees of cognition which the human mind successively attains in its intellectual development. The first of these periods begins at birth, and includes about six weeks, during which no definite cognitions can be assigned to the child, except that primary and fundamental one of being; the second begins with the first smile and tears, with the simple perception of things as subsisting constituting its cognitions, to which correspond the volitions, which have these things as their object. The third period is marked by the acquisition of speech, which shows that the child has attained the power of analysis and abstraction, with volitions having sensible qualities as their object. The fourth period shows itself in the aptitude to learn to read, and is characterized by the exercise of the faculties of judgment and comparison, and by the development of the moral sense, which was already existing in the germ. Thence are developed conscience, synthetic cognitions, and the free use of the reason. The executed work of Rosmini was terminated at this period; but he left notes from which it appears that he had intended to treat of four other periods, each marked by the development or perfecting of its peculiar faculties. We miss much by not having the completion of a work so well planned, but, "fortunately, the earlier part, which is preserved to us, contains the fundamental principles both of method and practice, which remain the same for all periods of life, and of which only the application varies with the varying degrees of individual development."

Text-Book of Zoölogy; for Junior Students. By Henry A. Nicholson, Regius Professor of Natural History in the University of Aberdeen. Fourth edition. New York: D. Appleton & Co. Pp. 388. Price, $1.60.

Professor Nicholson introduces the study of animals by some general considerations of the scope of zoölogy, the conditions of life, classification, and the distribution of animals in space and in time. The present edition of the work has been thoroughly revised and brought up to the present standard of zoölogical knowledge. Recent additions to our acquaintance with the existing or extinct fauna of the world have been noticed in the text, and some fresh illustrations have been added. The scope of the work does not allow space for long descriptions of extinct animals, but those whose characteristics throw light on the relations of living species are briefly described. The definitions of important divisions are printed in italics, and the book is copiously illustrated. A glossary and an index are appended.

Watson's Phonographic Instructor. By John Watson. New York and London: G. P. Putnam's Sons. Pp. 144.

The chief peculiarities in the method of teaching Pitman's phonography, which is embodied in this manual, are that vowel-placing and reading are postponed until considerable speed has been attained in writing the consonant outlines of words. When this point has been reached, the author claims that the pupil has become so well acquainted with word-forms that he can read the bulk of his writing without vowels. The pupil is then taught to place a vowel-mark here and there where it will do the most good, until he learns to use as many vowels as a reporter must use. Ability to read comes almost insensibly. A key to exercises occupies twenty-four pages of the volume, and several other pages are devoted to model outlines, contractions, and select phrases, but the author deems reading-lessons useless.

Railway Practice: Its Principles and Suggested Reforms Reviewed. By E. Porter Alexander. Pp. 60. Price, 75 cents. The Interstate Commerce Act: An Analysis of its Provisions. By John R. Dos Passos. New York: G. P. Putnam's Sons. Pp. 125. Price, $1.25.

Both of these books belong to the "Questions of the Day" series. The essay of Mr. Alexander appears to have been prepared with especial reference to Mr. T. F. Hudson's book and the articles of Mr. Ely on railroad questions, and to the Reagan bill. The three solutions offered by these persons disagreeing radically in principle, and being also at odds with the methods of reform which the railway managers themselves have instituted, there is some confusion in the premises from which the different parties start. The author's effort is to find means for removing the confusion. There must be a few principles at least settled by actual test and put beyond question or dispute to constitute what we might call the present state of the science of railway management. He therefore takes up the most important questions of railway management, and examines them in the light of those principles. Mr. Dos Passos gives in his book a systematic and detailed analysis of the provisions of the Interstate Commerce Act, preceded by a history of legislation on the subject, and supplemented by the text of the act itself. His exposition is as lucid as the law, which is far from being free from obscurities, will permit a commentator to make it.

A New Basis for Chemistry: A Chemical Philosophy. By Thomas Sterry Hunt, M. A., LL. D. (Cantab.). Boston: Samuel E. Cassino. Pp. 165.

From time to time since 1848 the author has been publishing portions of a theory of chemistry, designed to fill more perfectly the place occupied by the atomic hypothesis. The solution of one problem, namely, that of the relation of equivalent weight to specific gravity in liquids and solids, which was necessary to a complete chemical philosophy, was wanting till 1886, so that in the present volume the author first presents as a whole his new basis for chemistry. The several parts of the theory are set forth largely in quotations from the author's earlier writings. Professor Hunt agrees in the belief that such matter as forms the substances called elements on the earth exists in stars and nebulæ in a still more elementary and tenuous form. From this primary matter he deems all known substances to be formed by greater or less degrees of condensation. He regards chemical combination as an interpenetration of masses, by which "the uniting bodies come to occupy the same space at the same time," and names solution as the type of such union. What we are accustomed to call the liquid and solid states of a substance, he regards as polymers of the corresponding vapor, whose equivalent weights are as much higher as their densities are greater than that of the vapor. He deems the atomic theory unnecessary for explaining the law of definite proportions, and, from its making combination consist in juxtaposition, untenable. His views are supported by his studies in mineralogy, which have shown that the hardness of isomeric species and their indifference to chemical reagents increase with their condensation.

Brazil, its Condition and Prospects. By C. C. Andrews. New York: D. Appleton & Co. Pp. 352. Price, $1.50.

Brazil, the only other country on the Western Continent approaching our own in extent, and with 13,000,000 inhabitants, is to us well worth knowing. Yet there are few people in the United States to whom the information in this volume would not have the charm of novelty. The author gained his acquaintance with Brazilian affairs and customs during a residence of three years in Rio Janeiro as United States consul-general. His pages teem with facts in regard to routes of travel, houses, markets, conveyances, religion, business customs, the emperor, special localities, climate, foreign commerce, education, government, literature, agriculture, animals, slavery, immigration, and a host of other topics. The impression which the book conveys is that Brazil is not an especially desirable country for an American to emigrate to. It is difficult for a stranger to procure desirable lands for agriculture or stock-raising, and foreigners who attempt professional careers must struggle with jealousy and suspicion, besides formidable competition. The seclusion of young women seems to be still practiced with almost Oriental strictness on the plantations, as witness the following extract:

> Presently the senhora reappeared, leading one very modest looking damsel of about eighteen or nineteen years of age, and closely followed by three others, apparently somewhat younger. All appeared to be overwhelmed with intense shyness, and an almost hysterical desire to laugh. After a formal and separate introduction of each one—be it noted that the lady was here introduced to the gentleman—they all retired back again into the secret chamber, and their papa once more turned the key upon them. At this time we were ignorant of the custom, which I afterward found to be so general in these out-of-the-way parts, of keeping the women, or rather the daughters of the family, locked up like wild beasts.

Controlling Sex in Generation. By Samuel H. Terry. Second edition. With an Appendix of Corroborative Proofs. New York: Fowler & Wells Company. Pp. 209.

In order to more fully corroborate the views advanced in the body of this work, the author has added in this edition an appendix, consisting of extracts from "The Popular Science Monthly" and other periodicals, letters from cattle-breeders, etc, and a chapter in answer to objections.

The Cremation of the Dead. By Hugo Erichsen, M. D., with an Introductory Note by Sir T. Spencer Wells. Detroit: D. O. Haynes & Co. Pp. 264. Price, $2.

In this book the subject is considered from the æsthetic, sanitary, religious, historical, medico-legal, and economical points of view. The author is a warm advocate of cremation, and closes with a prediction that it will make more progress in the United States than in any other country of the world. The text is illustrated with several views and plans of crematoriums, urns, etc.

A Junior Course of Practical Zoölogy. By A. Milnes Marshall, M. D., F. R. S., assisted by C. Herbert Hurst. London: Smith, Elder & Co. For sale by G. P. Putnam's Sons, New York. Pp. xxiv–440.

This book is a laboratory manual designed as a guide to a practical acquaintance with the elements of animal morphology. In almost all cases the descriptions of animals are so arranged that the whole dissection can be performed on a single specimen. Strict uniformity of treatment has not been specially aimed at; thus the more difficult portions of the subject are treated at considerable length, while systems of subordinate educational value, such as the muscular, occupy little space. Few illustrations have been introduced lest the student should give too little attention to the drawings which he must make from his own dissections. The animals selected for description are amœba, and three other protozoa, hydra, liver-fluke, leech, earthworm, fresh-water mussel, edible snail, crayfish, cockroach, lancelet, dog-fish, rabbit, fowl, and pigeon.

Sanitary Examinations of Water, Air, and Food. By Cornelius B. Fox, M. D., F. R. C. P., London. With 110 Illustrations. Second edition. Philadelphia: P. Blakiston, Son & Co. Pp. 563. Price, $4.

The reliability of Dr. Fox's sanitary work led to the expansion of his pamphlet on "Water Analysis" into a volume containing sections on examinations of air and food, in 1878, and has now brought this volume to a second edition. The chief new features of this edition are the extension of water and air examination in the direction of those biological methods that have been introduced of late years, and that are deemed by German and French sanitarians as important as the chemical analysis. Recently devised improvements in the examination of milk are also recorded.

Due North: or Glimpses of Scandinavia and Russia. By Maturin M. Ballou. Boston: Ticknor & Co. Pp. 373.

The author visited Copenhagen and Elsinore, in Denmark, traveled over much of Sweden and Norway, saw the midnight sun, had a glimpse of Finland, visited St. Petersburg, Moscow, and Nijni-Novgorod, and spent a few days in Poland. His sketches of all these parts include accounts of scenery, buildings, people, customs, sites having historical interest or interesting by personal association, and observations on moral, social, political, and religious conditions. His view of the Czar and his government is decidedly more favorable than those which we are accustomed to hear expressed.

The True Doctrine of Orbits: An Original Treatise on Central Forces. By H. G. Rush, of New Danville, Pennsylvania. Pp. 133.

The author endeavors, by mathematical demonstrations, to prove that the orbits of the planets, and even of the comets, are not elliptical, as the Newtonian astronomy supposes, but circular.

Report of the Proceedings of the American Historical Association. Third Annual Meeting, April 27–29, 1886. Herbert B. Adams, Secretary. New York: G. P. Putnam's Sons. Pp. 104. Price, $1.

The membership of the Association has grown since its organization in September, 1884, from forty to four hundred and twenty-two members, seventy-eight of whom are life-members. The third meeting was held in Washington, and the discussions included such topics as the capture of Washington in 1814, and the campaigns of our late war, besides many others of a more general character, and some bearing upon what used to be called the philosophy of history. Among the achievements claimed for this meeting are the friendly reunion of military historians from the North and from the South; the peaceful discussion of the campaigns before Washington, and in the Valley of Virginia; the historical representation of the new South and the Northwest, as well as of the Northern States and Canada; the treatment of almost every branch of our American history; the meeting of the youngest historians with the very oldest—Mr. Bancroft; the mingling of representatives from various historical schools; and the presence of Congressmen and visitors from different parts of the Union. "It was a veritable national convention, in the political center of the United States, for the furtherance of American history and of history in America."

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## POPULAR MISCELLANY.

**Report upon the Charleston Earthquake.**—The United States Geological Survey, according to a communication from Messrs. Dutton and Hayden in "Science," has received reports relating to the Charleston earthquake from more than sixteen hundred localities, giving a much larger amount of information than has ever before been collected concerning any one earthquake. A considerable proportion of the reports were in answer to a printed list of questions which had been sent out, to direct attention to the most distinct and significant features of the phenomena. The first point to receive attention is the magnitude of the area affected by the shocks. The earthquake was felt in Boston, near Lake George, and at two points in the Adirondacks, at several places in Ontario, Michigan, and Wisconsin (at La Crosse, nine hundred and sixty-seven miles from Charleston, the most remote point within the United States which has given a positive report), in some of the Florida Keys, in Cuba, and in Bermuda, a thousand miles from Charleston. The area within which the shakings were marked enough to attract considerable attention, would be somewhat more than circumscribed by a circle of a thousand miles radius. The movement might, however, have been detected, by instrumental observation, over a much greater area. There are some large tracts within the area which show comparatively feeble intensity. The most conspicuous of them is the Appalachian region. This fact is of interest in its bearing on the supposition that mountain-ranges serve as barriers to the propagation of earthquakes. Another minimum area was in Indiana and Illinois; and it nearly corresponded with the area in which a considerable earthquake occurred on the 6th of February. The coincidence is curious, if not significant. At nearly all places within about two hundred and fifty miles of the center the energy of the shock was very great. Coming nearer to the center, the intensity increased on all sides, with differences in kind as well as in degree. "The phenomena characteristic of the epicentral area cease with something like abruptness as we radiate away from the epicentrum. The central phenomena are those produced by shocks in which the principal component of the motion of the earth is vertical. Proceeding outward, these predominating vertical motions pass, by a very rapid transition, into movements of which the horizontal component is the greater, and in which the undulatory motion becomes pronounced." The rapidity of these transitions, or the shape of the intensity-curve into which they may be translated, is supposed to be dependent upon the total energy and depth below the surface of the shock. The distance from the epicenter to the point where the rate of decline of the intensity is greatest, is simply proportional to the depth of the focus, and is the same whether the energy be greater or less. This gives a rule for estimating the depth of the focus. Applying the rule, we have a computed depth of twelve miles, with a probable error of one or two miles, for the focus of the principal shock at Charleston. There is reason for beliving that none of the great earthquakes of the last one hundred and fifty years have originated from a much greater, and few from as great, a depth. The city of Charleston was situated at from eight to ten miles outside of the area of maximum intensity. Had the seismic center been ten miles nearer to it, the calamity would have been incomparably greater than it was. The shocks were also probably made easier for the city by the loose nature of the soil and quicksands over which it is built. The time-data have not been fully worked out, but it is thought that they will give a speed of propagation exceeding three miles a second—a rate which "will probably prove unexpected to European seismologists."

**Some Popular Errors about the Eskimos.**—Mr. John Murdoch has exposed, in the "American Naturalist," a few popular errors in regard to the Eskimos, some of which have found their way into Hovelaque and Hervé's recent book on "Anthropology." Polyandry is not common among them, as is asserted there and by Bancroft, but is very rare, if it exists noticeably at all. Eskimo houses are seldom, if ever, holes dug in the earth, as the French authors say, but wooden, turf-covered lodges, built sometimes over an excavation of only moderate depth, as often wholly upon the surface, or else, farther north, they are the well-known snow-house. The people do not live a torpid existence in winter, but an extremely busy and active one, in employments which call out the energies, in some shape or another, of the whole family. The eating of raw flesh, which has been attributed to this people, is exceptional and usually practiced only under stress. The enormous consumption of fat, also, "supposed to be a physiological necessity to enable them to withstand the excessive cold, is probably the exception rather than the rule, to judge from the accounts of actual observers. It seems quite probable that the amount consumed in most cases is little, if any, greater than that eaten by civilized nations, when we consider that the people who eat the fat of the seal with the flesh, and use oil for a sauce to their dried salmon, have no butter, cream, fat bacon, olive-oil, or lard." The French authors correct one popular error in regard to the relative stature of the Eskimos, and declare that they are but little below the medium stature, having an average height of about five feet three inches, while "medium stature," according to Topinard, in five feet four inches. In comparing several series of measurements of Eskimos, only one was found that at all corroborates the popular opinion of their small size, and that gave the average height of twenty-three men at Cumberland Gulf as five feet 2·4 inches, still above Topinard's standard of small stature (five feet one and a half inch or less).

**The Coming Solar Eclipse.**—The total eclipse of the sun of August 19th will occur under circumstances offering unusual facilities for concurrent observation. The line of totality crosses Asia and Europe from Japan to the British Islands, and the phenomenon can be observed with the sun at a good height from all places on this line east of Moscow. Among these points are Tver, Petrovsk, Kineshma, Perm, Tobolsk, Tomsk, Krasnoyarsk, Irkutsk, and several stations in Japan, where the opportunities for observing will be even better than in Russia and Siberia. Professor C. A. Young will have a station at Tver, and parties of English and Italian astronomers will observe in the neighborhood. As nearly all the points in Russia and Siberia are connected by telegraph, the observing parties will have facilities for instantaneous communication with one another.

**Disposal of Sewage and Garbage.**—Mr. W. Howard White has given to the American Society of Civil Engineers his views as to the comparative value and feasibility of five different methods of disposing of sewage and garbage. The method of dry removal is still in most general use, and costs, in Leeds, England, including removal of ashes and garbage, twenty-four cents per head a year. The great defect of removal by water-carriage, such as prevails in all large cities, is that usually it only takes the nuisance to another place, without abating it. This fact, and the failure of the currents depended upon to carry the stuff far enough away, have led to the introduction of the method of water-carriage with works for purification by precipitation. This is effected at the Knostrop Works, Leeds, by means of a set of settling-basins, with milk of lime as the precipitant. At Frankfort, alumina ferric is to be used. The method of water-carriage, with filtration or irrigation, can be applied with great advantage in small towns; but in cities of more than one hundred thousand inhabitants it is met by the difficulty of getting enough land to make the effectual application of filtration or irrigation practicable. The method of dry removal and making up into salable products is practiced on a large scale at Manchester, England. Urine and fæces partially deodorized with the house-ashes are converted into manure and a variety of useful compounds at a cost of from twenty-four to thirty-seven cents per head a year. The Liernur separate pneumatic system is judged to be more expensive than any other well-arranged method. In some places in England and in Holland, refuse not suitable for the sewers is burned in destructors at small cost. At Leeds, the stuff is fed at the top of the apparatus, and works down gradually to the grate, where fire once started is kept up by the refuse itself. Dr. C. Meymott Tidy says that no single answer can be given to the question of the disposal of sewage. The adviser must sink his hobby and be prepared to find conditions under which he would counsel irrigation, and other conditions under which he would recommend precipitation. Success at one place furnishes no argument that a process will be successful everywhere. His own experience of all kinds of schemes has led him to prefer a scheme combining the principles of precipitation and irrigation. It has the advantages that its efficient working is independent of the weather; and that, if the works are sufficiently large, any emergency of quantity can be met.

**Atlantic and Pacific Fishes.**—Professor David S. Jordan has published, in the "Proceedings of the United States National Museum," a list of the fishes known off the Pacific coast of America, from the Tropic of Cancer to Panama. Our knowledge of these species is due chiefly to the studies of Dr. Gill, Dr. Günther, Dr. Steidachner, and Professors Jordan and Gilbert; and the work of the few collectors who have given special attention to the subject has in nearly all cases been of exceptional value. Of the four hundred and seven species of fishes now known from the Pacific coast of Mexico and Central America, seventy-one species, or seventeen and a half per cent, are also found on the Atlantic coast. If we add to this some eight hundred species, now known, from the Caribbean Sea and adjacent shores, we have about six per cent of the whole number known as common to the two coasts. With only this proportion of common species, the two faunæ show no greater resemblances than the similarity of physical conditions on the two sides of the continent would lead us to expect. This conclusion is opposed to the views expressed by Dr. Günther in his "Fishes of Central America," where he assumes that nearly one third of the total number of species of marine fishes on the two shores of tropical America will be found to be identical. Hence he infers that there must have been, at a comparatively recent date, a depression of the isthmus, producing an intermingling of the two faunæ. The discrepancy arises from the comparatively limited representation of the two faunæ, at the disposal of Dr. Günther. Several of the identical species are pelagic fishes common to most warm seas. Others are almost cosmopolitan in the tropical waters; while most of the rest often ascend the rivers of the tropics. We may account for their diffusion, perhaps, as we account for the dispersion of fresh-water fishes on the isthmus, on the supposition that they may have crossed from marsh to marsh at some time in the rainy season. Professor Jordan is therefore brought to the conclusion that the fish fauna of the two shores of Central America are substantially distinct, so far as species are concerned, and that the resemblance between them is not so great as to necessitate the hypothesis of the recent existence of a channel across the isthmus.

**Progress of Stellar Photography.**—From a paper by Professor E. C. Pickering, on "An Investigation in Stellar Photography, conducted at the Harvard College Observatory," it appears that the first work in this branch was an experiment made at the observatory in July, 1850, when, under the direction of Professor W. C. Bond, a satisfactory image of the star *α Lyræ* was obtained by Mr. J. A. Whipple. Subsequently, the double star *α Geminorum* gave an elongated image, evidently due to its two components. Objects as bright as these gave but faint images, and no impression was obtained from the pole-star, however long the exposure continued. The experiment was repeated with various stars and clusters, but the work was finally abandoned, owing to the imperfections of the driving-clock and the lack of sensitiveness of the plates. Both of these difficulties were partially remedied in 1857; the research was resumed by Professor G. P. Bond, and the value of stellar photography as a means of determining the positions and brightness of the components of double stars was established. The present research was undertaken in 1882, when it was shown that photography could be used as a means of forming charts of large portions of the sky, and of determining the light and color of stars in all parts of the heavens. Photographs of the trails of polar stars no brighter than the eleventh magnitude were obtained without clock-work. Stellar spectra were obtained of the brighter stars without clock-work, in which all the principal lines were well shown. The investigation having been resumed in 1885, with a larger telescope, one hundred and seventeen stars within 1° degree of the pole, each of them no brighter than the fourteenth magnitude, left trails. The average deviation of the measures of the brightness of these stars on different photographs was less than a tenth of a magnitude, a greater accordance than is given by any other photographic method. A similar result was obtained from the Pleiades, of which group more than fifty stars left trails. Trails are now being photographed of all the stars north of —30° in all right ascensions, and the work has been completed for more than half of the sky. By photographing on the same plate polar stars near their upper and lower culminations, material has been accumulated for determining the atmospheric absorption on each night of observation. A study has been made of the application of photography to the transit-instrument. By placing a large prism in front of the object-glass, excellent stellar spectra have been obtained. An exposure of five minutes gives the spectra of all stars brighter than the sixth magnitude within a region 10° square. About half of the region north of —25° has been photographed in this way. With an exposure of an hour, the spectra of stars no brighter than the ninth magnitude are shown. Over a hundred stars have thus been taken simultaneously on a plate by a single exposure. Miscellaneous observations have been secured of the Pleiades, of the nebula in Orion, of Jupiter's satellites, and of various other objects; also of the new star in Orion, and of its spectrum, and one plate showing that this star must have been much fainter on November 9, 1885, than when discovered five weeks later.

**The Prospect for Silk-Culture in the United States.**—Dr. C. V. Riley, of the Entomological Division of the Agricultural Bureau, said in the preface to the second edition of his "Manual of Silk-Culture," in 1882, that the elements of successful silk-culture on a large scale were entirely wanting in this country; that "the profits of silk-culture are always so small that extensive operations by organized bodies must prove unprofitable where capital finds so many more lucrative fields for employment; that extensive silk-raising is fraught with dangers that do not beset less ambitious operations, "and that silk-culture is to be recommended only as a light and pleasant employment for those members of the farmer's household who either can not do or are not engaged in otherwise remunerative work." In the latest edition of the "Manual" (1886) the author regrets that his original estimates, made in 1879, of the profitableness of the enterprise have been criticised because they had not been realized—the trade had, in fact, been passing through a period of depression; and he reiterates the caution that "silk-raising on an extensive scale is fraught with so many dangers, that it is inadvisable to invest capital in such an enterprise." Silk-culture, he says in another place, "is not (and it never has been) an exceedingly profitable business; but it adds vast wealth to the nations engaged in it, for the simple reason that it can be pursued by the humblest and poorest, and requires so little outlay. The question of its establishment in the United States is, as I have elsewhere said, a question of adding to our own productive resources. There are hundreds of thousands of families in the United States to-day who would be most willing to add a few dollars to their annual income, by giving light and easy employment for a few months each year to the more aged, to the young, and especially to the women of the family, who may have no other means of profitably employing their time."

**Wood and Metal for Railroad-Ties.**—M. Henri Mathieu, chief-engineer of the French railway *du Midi*, from observations on the consumption of the wood ties on French railways, has found that their duration depends upon several factors, among which are the material employed, the climate, the ground, and the ballasting. It principally depends upon the system of preparing the ties, and the quality of the antiseptic material; and the observations made on one line often differ from those made on another line. Averaging the results—oak ties, not prepared, last fourteen years; when creosoted, eighteen years. Creosoted beech ties last from eight to ten years; creosoted ties of pines of the Landes, twelve years; prepared with sulphate of copper, from eight to twelve years. While, as between wood and the substitution of metal for it, M. Mathieu favors sticking to wood, he admits that the substitution of steel for iron is an important matter, and that one of the principal inconveniences of the metallic ties—want of solidity in the joints—may be obviated by careful attention during the first two years, which will make the rails and the sleepers solid. Metallic ties should be made heavier than they are, if they are to succeed. They had been laid, at the beginning of 1884, on 5,708 kilometres of lines in Germany, Austria, Holland, Belgium, and Switzerland.

**Some Ancient Philosophy.**—A book called "Speculum Mundi, or a Glass representing the Face of the World," published in 1670, gives a curious picture of what passed for science before the great modern discoveries were made. It consists of a chapter on each of the six days of creation. It says that the world was at first an unfashioned lump. Having disposed of the question of the firmament as best it could, it says of the air that the highest region is said to be "exceeding hot," because of the stars. Meteors and comets, it informs us, are "composed of Vapours or Fumes—a kinde of Smoak." Some of these vapors "transcend" very high, "even to the Starry Heaven itself; which is witnessed by our best Modern Astronomers, who have observed many Comets above the Moon." Great events are connected with comets, because those bodies consist of "many hot and dry Exhalations" and "distemper the Air," which "the Bellows of the Body suck in and receive; insomuch that there cannot but be Sickness, Plague, and much mortality." Moreover, these "poysonous breathings" are "very apt so to disorder and dry up the Blood in Humane Bodies, that thereby great store of red and a dust choler may be purchased; and this stirreth up to anger with the thought of many furious and violent actions, and so by consequence to war." Thunder is caused "by reason of Hot and Dry Exhalations shut within the cloud, which, seeking to get out, with great Violence do knock and rend the cloud." The hot and dry exhalation in escaping is set on fire by the violence, and becomes lightning, when it often continues burning until it falls to the ground. "And oftentimes a great stone is blown out of the cloud with it; whose cause is also natural." For, when the exhalation is drawn up from the earth, it sometimes takes earthy matter "like unto the finest sand" with it, and this, "through the moisture which it getteth in the Air," "clottereth together," and, "by the excessive heat which it findeth in the general matter of the exhalation," becomes hard like a brick. Sometimes the exhalations carry up also frogs, fishes, and grain, or the vehement heat of the sun draws milk, and we are treated to curious showers of corresponding nature. We are also informed that the long, streaming threads seen floating in the air, and vulgarly supposed to be spiders' webs, are nothing of the kind, but meteors, which "may rightly be supposed to proceed out of a through-boyled or digested vapour, being mixed with earthy and slimy Exhalations."

**Tourist and Alpine Clubs.**—A manual of the Tourist Unions of the world—under which designation are included Mountain and Alpine clubs and the like—published by Herr R. Koehler at Eisenach, shows that these associations, which are really of recent origin, have thriven greatly. The census of them gives a total of 78 clubs or unions, with 775 sections and 79,955 members. Of these, 73 clubs, with 770 sections and 79,365 members, are in Europe; four clubs, with 590 members, in America; and one club in Asia. The largest of them all is the German and Austrian Alpine Union, which has 109 sections and 12,274 members. Their special organizations and objects vary according to the characteristics of the nation in which they severally exist, but the common object of them all is the study, exploration, and enjoyment of natural scenery, with a prominent place given to mountain-climbing.

**Artificial Rubies.**—Mr. George F. Kunz recently read a paper before the New York Academy of Sciences on some artificial rubies that have been offered in the market of Paris as genuine rubies from a new locality.

On examination of specimens of the stones the author found their principal distinguishing characteristic to be the presence of spherical bubbles, rarely pear-shaped, or having stringy portions showing how they had moved, but with the ends always rounded, and presenting a cloudy appearance or an arrangement in wavy groups. In natural rubies the cavities are always angular or crystalline in outline, and are usually filled with liquid; or, sometimes they are arranged with the lines of growth, forming part of a feather, as it is called by jewelers. In many genuine rubies we find a silky structure which appears under the microscope to be a series of cuneiform or acicular crystals, usually iridescent. No traces of these have been found in the artificial specimens. The stones are about equally hard and of nearly equal specific gravity with genuine rubies. Their color is good, but not so brilliant as that of a very fine ruby. The syndicate of diamonds and precious stones of Paris has directed that all stones of this kind shall be marked artificial, else they will be considered fraudulent, and sellers of them will be dealt with accordingly.

## NOTES.

The retiring President of the American Association for the Advancement of Science, who will give the presidential address at the New York meeting, is Professor Edward S. Morse, of Salem, Massachusetts. He will review what American zoölogists have done to advance the doctrine of evolution. Professor S. P. Langley, of Washington, will enter upon the office of president at this meeting. The vice-presidents, who are to preside over the several sections, are: A. Mathematics and Astronomy, William Ferrel, of Washington; B. Physics, W. A. Anthony, of Ithaca, New York; C. Chemistry, Albert B. Prescott, of Ann Arbor, Michigan; D. Mechanical Science, Eckley B. Coxe, of Drifton, Pennsylvania; E. Geology and Geography, G. K. Gilbert, of Washington; F. Biology, W. G. Farlow, of Cambridge, Massachusetts; H. Anthropology, D. G. Brinton, of Media, Pennsylvania; J. Economic Science and Statistics, Henry E. Alvord, of Amherst, Massachusetts.

The American Public Health Association will hold its fifteenth annual meeting this year at Memphis, Tennessee, November 8th to 11th. The topics to be considered are: "The Pollution of Water-Supplies"; "The Disposal of Refuse Matter of Cities"; "The Disposal of Refuse Matter of Villages, Summer Resorts, and Isolated Tenements"; and "Animal Diseases dangerous to Man."

The Indian Government has arranged a scheme for the complete and systematic botanical survey of India, for which purpose the country has been divided into four great districts, with a superintendent of survey in each. The flora of the Philippine Islands has been under study by Dr. Sebastian Vidal, Director of the Botanical Garden at Manila and the commission for studying the forest flora; and the work is provided for, for still another year at least, in the public budget.

Sir Lyon Playfair, in opening a new Industrial Institute at Bromley, England, recently, said that hitherto the country had prided itself upon the practical knowledge of its artisans, but it had relied too entirely upon that knowledge. The consequence had been that the countries which nurtured the intellects of the people had stepped in, and with their superior mental education had showed the world that the competition of the day was not one of local advantages, but a competition of intellect. England was realizing her position now, and training her sons by technical schools to compete intellectually with the countries round her, from whom she had learned her lesson.

Mr. George H. Blagrove, in a paper on "House Construction in Relation to Health," suggests that great sanitary advantages might be gained if towns were laid out with the streets in the diagonal directions—northeast and southwest, northwest and southeast. Some of the suburban towns near New York are laid out in this way, and—the sun shining into all the rooms some time during every day in the year, and nearly every day into all the windows—the effect is very cheering and salutary.

The fact is suggestive of the intensity of the strain of city life, that, while from 1852 to 1868 the population of Chicago increased 5·1 times and the death-rate 3·7 times, the deaths from nervous disorders increased 20·4 times.

Rats are accustomed to inhabit the buildings at South Kensington while the exhibitions are in progress. When the exhibitions close, they become starved, and leave the buildings in obviously great numbers. The rat population appears to have been greater than ever during the recent Colonial and Indian Exhibition, and they appeared everywhere, even eagerly going into the traps, which they avoided at other times. At length they entered upon a struggle for existence among themselves, and kept it up till all the young and weaker rats were devoured.

Among the relics found in the high mound, on the Ohio River, opposite Portsmouth, Ohio, were two crosses and thirty buckles of silver. The crosses were decorated with leaves, but furnished no clew as to their date; but one of the buckles, which was heart-shaped, bore the French crown of 1730 or 1740. The whole outfit probably belonged to a convent of one of the Jesuit missionaries. The discovery indicates that the mound was used for burials down to quite recent times.

Emin Bey, as he is known, Emin Pasha, as he has been promoted to be, Dr. Schnitzler, as he is in his patronymic, has been for ten years in the Egyptian service, for most of the time successful governor of the Equatorial Province. He has done much for science through his contributions to Petermann's "Mitteilungen" and the "Proceedings" of the Zoölogical Society; and he is described in "Nature" as "a good type of the kind of explorer that is wanted, now that mere pioneering work has been pretty well exhausted; a man well qualified by his scientific training to remain in a particular region for years if necessary, and study it in all its aspects."

Dr. Frantzel, of Berlin, reporting on the effects of immoderate smoking upon the heart, says that smoking, as a rule, agrees with persons for many years, although by degrees cigars of a finer flavor are chosen. But all at once, without any assignable cause, troubles are experienced with the heart, which compel the calling in of the doctor. Common cigars are not so liable to produce these effects as the finer flavored ones. Nor can the charge be laid upon cigarettes, although they produce evils of their own. The troubles seldom begin till after the smoker is over thirty years of age, and most usually attack him at between fifty and sixty. While it has not been determined what it is that makes smoking injurious, it appears certain that the effect does not depend upon the amount of nicotine.

Mr. W. Doberck, Director of the Hong-Kong Observatory, has prepared a table of the relative frequency per year of dangerous storms in different seas and gulfs, which shows the following results: Arabian Sea, 70; Bay of Bengal, 115; Southern Indian Ocean, 53; Java Sea, 12; China Sea, 214; Gulf of Mexico, 355. The hurricanes of the Antilles and the typhoons of the China Sea show a kind of monthly variation. The former have their maximum in August and their minimum in January; with the latter, the maximum is in December and the minimum in February. In the Java Sea and the Southern Indian Ocean, the maximum occurs in February; in the Bay of Bengal, in October; and in the Arabian Sea, in June.

Two of the recent grants made by the trustees of the Elizabeth Thompson Science Fund are in aid of American work: one of two hundred dollars for the investigation of underground temperatures by a committee of the Natural History Society; and one of five hundred dollars to Professor E. D. Cope, to secure the services of a skilled *préparateur* in working out the material accumulated for the continuance of his researches on American fossil vertebrates.

## OBITUARY NOTES.

Thomas Stevenson, the eminent constructor of the Bell Rock and numerous other lighthouses, died May 8th, in the sixty-ninth year of his age. He bore a part in the designing and construction of thirty lighthouses, and in numerous river, harbor, and dock works. The results of his experiments on the force, height, and action of sea-waves, are published in his book "On the Design and Construction of Harbors." He was the author of great improvements in lighthouse-lighting, and the optical apparatus in each of his lighthouses was especially adapted to the situation. The results of his researches on this point are given in the book "Lighthouse Construction and Illumination," which has been translated into German. He was also interested in theological questions, and wrote tracts upon them.

Professor Johan Edvard Areschoug, the Swedish botanist, died in Stockholm, May 7th, in the seventy-seventh year of his age. He was made Reader in Botany in the University of Lund in 1839, and was appointed Professor of Botany in the University of Upsala in 1858. He held the last position till 1876. He was the author of numerous papers and monographs on botanical subjects.

Dr. Albert Kellogg, botanist, died in Alameda, California, March 31st, at seventy-four years of age. He was born in Connecticut, and went to California in the early days of its American settlement. He investigated the botany of California during more than thirty years; was one of the founders of the California Academy of Sciences, to whose "Proceedings" he was a frequent contributor; and was attached to the special expedition to Alaska in 1867 as surgeon and botanist.

The death is reported of Dr. Alexander Ecker, professor at the University of Freiburg, in the seventy-first year of his age. He was a distinguished anatomist and pathologist, and was founder of the Ethnographical Museum at Freiburg.

Dr. Karl Friedlander, professor at the University of Berlin, an eminent pathologist and anatomist, has recently died.

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# THE ECONOMIC DISTURBANCES SINCE 1873.

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III.

[IN the preceding article of this series (No. II) two propositions were submitted: *First*, that in the increased control during the last quarter of a century, which mankind has acquired over the forces of Nature, and the increased utilization of such control for the work of production and distribution, is to be found a cause amply sufficient to account for the almost universal and extraordinary economic disturbance which has prevailed since 1873, and bids fair in a greater or less degree to continue. *Second*, that all the other causes which have been popularly regarded as having directly occasioned or essentially contributed to the economic disturbance in question—with the exception of such as are in the nature of natural phenomena, as bad seasons and harvests, diseases of plants and animals, disappearance of fish and the like, and such as are due to excessive taxation, consequent on war expenditures, all of which are local, and the first temporary in character—naturally group themselves about the one great cause that has been suggested, as sequences or derivatives, and as secondary rather than primary in their influence. A summary of the evidence in support of the *first* proposition having been submitted, it is proposed in the following article to ask attention to the facts which seem to be confirmatory of the *second*.]

OVER-PRODUCTION.—Consider *first* the most popular alleged cause of recent economic disturbances, that to which the Royal Commission of Great Britain in its final report * (December, 1886), and

* "One of the commonest explanations of this depression or absence of profit is that known under the name of over-production; by which we understand the production of commodities, or even the existence of a capacity for production, at a time when the demand is not sufficiently brisk to maintain a remunerative price to the producer, and to afford him an adequate return on his capital. We think such an over-production has been one of the most prominent features of the course of trade during recent years; and that the depression under which we are now suffering may be partially explained by this fact."—*British Commission, majority report.*

"By over-production we understand the production of commodities (or existence of the agencies of production) in excess, not of the capacity of consumption if their distribution was gratuitous, but of the demand for export at remunerative prices, and of the

the United States Bureau of Labor* (1886) have assigned a prominent place; and which the "Trades-Union Congress of England has by resolution accepted as being, in the opinion of the workmen of England," the most prominent cause, namely, "*over-production.*" In a certain sense there can be no over-production of desirable products so long as human wants for such products remain unsatisfied. But it is in accordance with the most common of the world's experiences, that there is at times and places a production of most useful and desirable things in excess of any demand at remunerative prices to the producer. This happens, in some instances, through lack of progress or enterprise, and in others through what may be termed an excess of progress or enterprise. An example of the first is to be found in the circumstance that in the days of Turgot, the French Minister of Finance under Louis XVI, there were at times in certain departments of France such abundant harvests that wheat was almost unmarketable, while in other and not far-distant sections of the country there was such a lack of food that the inhabitants perished of hunger; and yet through the absence of facilities for transportation and communication of intelligence, the influence of bad laws, and the moral inertia of the people, there was no equalization of conditions.† An example of the second, intensified to a degree never before experienced, is to be found in the results of the improvements in production and distribution which have been made especially effective within the last quarter of a century. A given amount of labor, operating through machinery, produces or distributes at least a third more product on the average, in given time, than ever before. Note the natural tendency

amount of income or earnings available for their purchase in the home market. The depression under which we have so long been suffering is undoubtedly of this nature."—*British Commission, minority report.*

* "Machinery—and the word is used in its largest and most comprehensive sense—has been most potent in bringing the mechanically-producing nations of the world to their present industrial position, which position constitutes an epoch in their industrial development. The rapid development and adaptation of machinery in all the activities belonging to production and transportation have brought what is commonly called over-production; so that machinery and over-production are two causes so closely allied that it is difficult to discuss the one without taking the other into consideration. . . . The direct results, so far as the present period is concerned, of this wonderful and rapid extension of power-machinery are, for the countries involved, over-production, or, to be more correct, bad or injudicious production; that is, that condition of production of things the value of which depends upon immediate consumption, or consumption by that portion of the population of the world already requiring the goods produced."—*Report of the United States Commissioner of Labor, 1886, pp. 88, 89.*

† This experience of France in the last quarter of the eighteenth century is repeating itself at the present day in China. General Wilson, in his recent "Study of China" (1887), states that "over ten million people died from starvation about ten years ago in the provinces of Shansi and Shensi alone, while abundance and plenty were prevailing in other parts of the country. Every effort was made to send food into the stricken regions; but owing to the entire absence of river and canal navigation, as well as of railroads, but few of the suffering multitudes could be reached."

of human nature under the new conditions. The machinery which thus cheapens and increases product is, as a rule, most costly, and entails a like burden of interest, insurance, and care, whether it is at work or idle ; and the possessor of it, recognizing this fact, naturally desires to convert outlay into income by utilizing it to the greatest extent possible. Again, a man who has learned by experience that he can dispose of a certain amount of product or service at a profit, naturally reasons that a larger amount will give him, if not a proportionally greater, at least a larger aggregate profit ; and as the conditions determining demand are not only imperfectly known, but to a certain extent incapable of exact determination, he discards the idea of any risk, even if he for a moment entertains it, and pushes industrial effort to its maximum. And as this process is general, and, as a rule, involves a steady increase in the improved and constantly improving instrumentalities of production and distribution, the period at length arrives when the industrial and commercial world awakens to the fact that there is a product disproportionate to any current remunerative demand. In this way only is it possible to account for the circumstance that the supply of the great articles and instrumentalities of the world's use and commerce has increased, during the last ten or fifteen years, in a far greater ratio than the contemporaneous increase in the world's population, or of its immediate consuming capacity. But although such is substantially a correct general exposition of the recent course of industrial events, and although all the agencies concerned in reducing the time and labor necessary to effect a given result in the world's work have undoubtedly acted to a certain extent and in all cases in unison, the diversity of method, under which the supply in excess of remunerative demand, or the so-called over-production has been specially effected, is not a little curious. Thus, in the case of crude iron and steel, cotton fabrics and textiles generally, coal, most articles of metal fabrication, ships, and the like, the increase and cheapened supply have been brought about mainly through improvements in the machinery and economy of production ; while in the case of wheat, rice, and other cereals, wool, cotton-fibers, meats, and petroleum, like results have been mainly occasioned by improvements in the machinery and economy of distribution. On the other hand, in the case of copper, tin, nickel, silver, quicksilver, quinine, and some important chemicals, over-production, in the sense as above defined, has been almost entirely due to the discovery of new and abundant natural sources of supply. It is also not to be overlooked that other factors, which can not properly be included within the sphere of the influence of recent discoveries and inventions, have also powerfully contributed to bring about the so-called phenomenon of over-production. The increase in the consumption of some commodities is entirely dependent upon the increase in the tastes and intelligence of the masses ; and it is undeniable that the culture of the manual laborers of the world has not advanced concurrently, in recent years, with the increased and cheapened production of such articles. Many things, consequently, have been, as it were, showered upon these classes, which they do not know how to use, and do not feel that they need, and for which, therefore, they can create no market. A man who has long been contented with one shirt a week, is not likely to wish to use seven immediately, even if he can buy seven for the price that he formerly paid for one, and his wife takes pleasure in doing his washing. But the most remarkable example of this nature is to be found in the case of sugar, which takes precedence over most of the articles which enter largely into the world's commerce and consumption in respect to extraordinary increase of product, and equally extraordinary decline in price within recent years, and mainly (as will be hereafter shown) by reason of wholly artificial agencies—bounties—rather than from improvements in machinery and processes, or increased facilities for distribution.

One of the inevitable results of a supply of product or service in excess of remunerative demand (i. e., over-production) is a decline of price; and as the power of production and distribution has been increased in an unexampled degree since 1873 (as has been already shown), the prices of nearly all the great staple commodities of commerce and consumption have declined within the same period (as will be hereafter shown), in manner altogether without precedent in all former commercial history. That this experience has been altogether natural, and what might have been expected under the circumstances, will appear from the following considerations:

If production exceeds, by even a very small percentage, what is required to meet every current demand for consumption, the price which the surplus will command in the open market will govern and control the price of the whole; and if it can not be sold at all, or with difficulty, an intense competition on the part of the owners of accumulated stocks to sell will be engendered, with a great reduction or annihilation of all profit. Mr. John Bright, of England, in one of his recent speeches, relates the following incident of personal experience: "I know," he said, "a company manufacturing chemicals of some kind extensively, and one of the principal persons in it told me that in one of those high years, 1872, 1873, and 1874, the profits of that concern were £80,000, and he added that when the stock-taking and its results were communicated to the leading owner in the business, he made this very wise observation: 'I am very sorry to hear it, for you may depend upon it in the years that are to come we shall have to pay the whole of it back'; and in speaking to me of it he said, 'It is quite true, because for several years we have been able to make no dividend at all.' Well, why was that? The men who were making so large incomes at that time reinvested their money in increasing their business. Many of the concerns in this trade doubled their establishments, new companies were formed, and so the produce of their manufacture was extended to such a degree that the prices went down and the profits vanished."

As prices fall and profits shrink, producers working on insufficient capital, or by imperfect methods, are soon obliged, in order to meet impending obligations, to force sales through a further reduction of prices; and then stronger competitors, in order to retain their markets and customers, are compelled to follow their example; and this in turn is followed by new concessions alternately by both parties, until gradually the industrial system becomes depressed and demoralized, and the weaker succumb (fail), with a greater or less destruction of capital and waste of product. Affairs now having reached their minimum of depression, recovery slowly commences. Consumption is never arrested, even if production is, for the world must continue to consume in order that life and civilization may exist. The continued increase of population also increases the aggregate of consumption; and, finally, the industrial and commercial world again suddenly realizes that the condition of affairs has been reversed, and that now the supply has become unequal to the demand. Then such producers as have "stocks on hand," or the machinery of production ready for immediate and effective service, realize large profits; and the realization of this fact immediately tempts others to rush into production, in many cases with insufficient capital (raised often through stock companies), and without that practical knowledge of the detail of their undertaking which is necessary to insure success, and the old experience of inflation and reaction is again and again repeated. Hence, the explanation of the now much-talked-of "periods" or "cycles" of panic and speculation, of trade activity and stagnation. Their periodical occurrence has long been recognized, and the economic principles involved in them have long been understood. But a century ago or more, when such a state of affairs occurred in any country, it was mainly confined to such country, as was notably the case in John Law's "Mississippi Scheme," or the English "South-Sea Bubble," in the last century, or the severe industrial and financial crises which occurred in Great Britain in the earlier years of the present century—and people of other countries, hearing of it after considerable intervals, and then vaguely through mercantile correspondence, were little troubled or interested. During recent years, however, they have become less local and more universal, because the railroad, the steamship, and the telegraph have broken down the barriers between nations, and, by spreading in a brief time the same hopes and fears over the whole civilized world, have made it impossible any longer to confine the speculative spirit to any one country. So that now the announcement of any signal success in any department of production or mercantile venture, at once fires the imagination of the enterprising and reckless in every country, and quickly incites to operations which, without such a leaven of stimulus, would probably never be undertaken. The so-called cycles of inflation and depression have also undoubtedly in recent years become more frequent and intense, because the instrumentalities of production and distribution work more rapidly in effecting results than at any former period.

One universally recognized and, to some persons, perplexing peculiarity of the recent long-continued depression in trade is, the circumstance that while profits have been so largely reduced that, as the common expression goes, "it has not paid to do business," the volume of trade throughout the world has not contracted, but, measured by quantities rather than by values, has in many departments notably increased. The following are some of the more notable examples of the evidence that can be offered in confirmation of this statement :

The years 1879, 1880, and 1881, for the United States were years of abundant crops and great foreign demand, and are generally acknowledged to have been prosperous ; while the years 1882, 1883, and 1884 are regarded as having been years of extreme depression and reaction. And yet the movement of railroad freights throughout the country greatly increased during this latter as compared with the former period ; the tonnage carried by six railroads centering at Chicago in 1884 having been nearly thirty-three per cent greater than in 1881 ; and the tonnage carried one mile by all the railroads of the United States in 1884—a year of extreme depression—having been 5,000,000,000 in excess of that carried in 1882 ; and this, notwithstanding there was a great falling off, in 1884, in the carriage of material for new railroad construction. Again, the foreign commerce of the United States, measured in dollars, largely declined during the same later period ; but, measured in quantities, there was but little decrease, and in the case of not a few leading articles a notable increase. Thus, for the year 1885, the total value of the foreign commerce of the country in merchandise was $93,251,921 less than in the preceding year (1884), but of this decrease $90,170,364, according to the estimates of the United States Bureau of Statistics, represented a decline in price. An export of 70,000,000 bushels of wheat from the United States in 1884 returned $75,000,000 ; while an export of 84,500,000 in 1885 gave less than $73,000,000. An export of 389,000,000 pounds of bacon and hams in 1884 brought in nearly $40,000,000 ; but shipments of 400,000,000 pounds in 1885 returned but $37,000,000, or an increase of foreign sales of about 11,000,000 pounds was accompanied by a decline of about $3,000,000 in price. In 1884 the United States paid about $50,000,000 for 535,000,000 pounds of imported coffee ; in 1885 it imported 573,000,000 pounds for $47,000,000. In 1877, 216,287,891 gallons of exported petroleum were valued at $44,209,360 ; but in 1886, 303,911,698 gallons (or 87,623,000 gallons more) were valued at only $24,685,767, a decline in value of $19,683,000. But the most remarkable example of changes of this character is to be found in the case of sugar. Thus, in 1883 the United States imported 2,023,000,000 pounds of sugar, for which it paid $91,959,000. In 1885, 2,548,000,000 pounds were imported, at a cost of $68,531,000 ; or a larger quantity by 525,-000,000 pounds was imported in 1885, as compared with 1883, for $23,-428,000 less money.

The statistics of the recent foreign trade of Great Britain, as reported to the British Board of Trade, by Mr. Giffen, also exhibit corresponding results. For example, the declared aggregate value of British exports and imports for 1883 were £667,000,000 as compared with £682,000,000 in 1873, an apparent decline of no little magnitude. But if the aggregate of the foreign trade of Great Britain for 1883 had been valued at the prices of 1873, the total in place of £667,000,-000, would have been £861,000,000, or an increase for the decade of about thirty per cent.

An explanation of this economic phenomenon of recent years, namely, a continuing increase in the volume of trade, with a continuing low rate or decline in profits, may be found in the following circumstances : One constant result of a decline in prices is an increase (but not necessarily proportional or even universal) in consumption. Evidence on this point, derived from recent experiences, will be referred to hereafter ; but the following example illustrates how this economic principle manifests itself even under unexpected conditions :

The price of sulphate of quinine of American manufacture in July, 1879, was $3.35 per ounce in bulk. In June, 1886, the quotation for the same article in bulk was 68 cents per ounce. Quinine is used mainly as a medicine, and is so indispensable in certain ailments that it may be presumed that its cost in 1879 was no great restriction on its consumption, and that no great increase in its use from a reduction in price was to be expected, any more than an increase in the use of coffins for a similar reason—both commodities being used to the extent that they are needed, even if a denial of the use of other things is necessary, in order to permit of their procurement. And yet, that increase in the cheapness of quinine has been followed by a notable increase in its consumption, is shown by the fact that the importation of cinchona-bark—from which quinine is manufactured—into Europe and the United States during recent years has notably increased ; about 4,000,000 pounds having been imported into the United States in 1886, as compared with an import of 2,580,000 in 1883. The following statement also illustrates even more forcibly the ordinary effect of a reduction of price on the consumption of the more staple commodities : Thus, a reduction (saving) of 6*d.* (twelve cents) per week, in the cost of the bread of every family in Great Britain (a saving which, on the basis of the decline in the wholesale prices of wheat within the last decade, would seem to have been practicable), has been estimated as equivalent to giving a quarter of a million pounds sterling, or $1,250,000 per week, to the whole people of the Kingdom, to be spent for other things.

The evidence is also conclusive that the ability of the population of the world to consume is greater than ever before, and is rapidly increasing. Indeed, such a conclusion is a corollary from the acknowledged fact of increased production—the end and object of all production being consumption. Take, for example, the United States, with its present population of sixty million—a population that undoubtedly produces and consumes more per head than any other equal number of people on the face of the globe, and is producing and consuming very much more than it did ten or even five years ago. The business of exchanging the products or services, and of satisfying thereby the wants of such a people is, therefore, necessarily immense, and with the annual increase of population, and with consuming power increasing in an even larger ratio, the volume of such business must continue to increase. And what is true of the United States is true, in a greater or less degree, of all the other nations of the globe. There is, therefore, nothing inconsistent or mysterious in the maintenance or increase in the volume of the world's business contemporaneously with a depression of trade—in the sense of a reduction of profits—occasioned by an intense competition to dispose of commodities, which have been produced under comparatively new conditions in excess of a satisfactory remunerative demand in the world's markets.

The popular sentiment which has instinctively attributed the remarkable disturbance of trade within recent years to the more remarkable changes which have taken place concurrently in the methods of production and distribution has, therefore, not been mistaken. The almost instinctive efforts of producers everywhere to arrest what they consider "bad trade" by partially or wholly interrupting production has not been inexpedient; and the use of the word "over-production," stripped of its looseness of expression, and in the sense as defined by the British Commission (and as heretofore shown), is not inappropriate in discussing the economic phenomena under consideration. It would also seem as if much of the bewilderment that is still attendant upon this subject, and the secret of the fruitlessness of most of the elaborate inquiries that have been instituted concerning it, have been due mainly to an inability to distinguish clearly between a causation that is primary, all-sufficient, and which has acted in the nature of unity, and causes which are in the nature of sequences or derivatives. One striking illustration of this is to be found in the tendency of many of the English writers and investigators to consider the immense losses which British farming capital has experienced since 1873, as alone sufficient to account for all the disturbances to which trade and industry in the United Kingdom have been subjected during the same period. That such losses have been extensive and disastrous without precedent, is not to be questioned. Sir James Caird estimates this loss in the purchasing power of the classes engaged in or connected with British agriculture, for the single year 1885, as having amounted to £42,800,000 ($214,000,000) ; and as the losses for several preceding years are believed to have been equal or even greater than this, an estimate of a thousand million dollars decline in the value of British farming capital since 1880, from depreciation of land-values, rentals, and prices for stock and cereals, is probably an *under* rather than an *over*-estimate. Wheat-growing, which was formerly profitable in Great Britain, is reported as not having been remunerative to the British farmer since 1874 ; a fact that finds eloquent expression in the acknowledged reduction in British wheat acreage from about 4,000,000 acres in 1869 to 2,528,905 in 1886. That the agricultural populations of the interior states of Europe, which have hitherto been protected in a degree by the barrier of distance against the tremendous cheapening of transportation, are also at last beginning to feel the full effects of its influence, is shown by the statement (United States consular reports, 1886) that farming land in Germany, remote from large cities, where the demand for milk and other perishable products is small, can now be purchased for fifty per cent of the prices which prevailed at the close of the Franco-German War in 1870–'71. And yet such startling results, in the place of being prime factors in occasioning a depression of British trade and industry, are really four removes from the original causes, which may be enumerated in order as follows : *First*, the occupation and utilization of new and immense areas of cheap and fertile wheat-growing land in the United States, Canada (Manitoba), Australia, and the Argentine Republic. *Second*, the invention and application of machinery for facilitating and cheapening the production and harvesting of crops, and which on the wheat-fields of Dakota (as before pointed out) have made the labor of every agriculturist equivalent to the annual production of five thousand five hundred bushels of wheat. *Third*, the extension of the system of transportation on land through the railroad, and on sea through the steamship, in default of which the appropriation of new land and the invention and application of new agricultural machinery would have availed but little. *Fourth*, the discovery of Bessemer, and the invention of the compound (steamship) engine, without which transportation could not have cheapened to the degree necessary to effect the present extent of distribution. Now, from the conjoined result of all these different agencies has come a reduction in the world's price of wheat to an extent sufficient to make its growing unprofitable on lands taken at high rents, and under unfavorable climatic conditions ; and legislation is powerless to make it otherwise. In short, the whole secret of the recent immense losses of the British and to a lesser extent also of the Continental agriculturist, and the depression of British trade and industry, so far as it has been contingent on such losses, stands revealed in the simple statement that American wheat sold for export at the principal shipping ports of the United States in 1885 for 56 cents less per bushel than in 1874, 32 cents less than in 1882, and 20 cents less than in 1884.* "I have calculated that the produce of five acres of wheat can be brought from Chicago to Liverpool at less than the cost of manuring one acre for wheat in England."—*Testimony of* W. J. Harris, *a leading farmer in Devonshire, England, before the British Commission, 1886.* And what has happened in the case of wheat has happened also in a greater or less degree as respects meats and almost all other food products; increased supplies having occasioned reduction of prices, and reduction of prices, in turn, ruinous losses to invested capital, and revolutionary disturbances in old methods of doing business. The Bessemer rail, the modern steamship, and the Suez Canal have brought the wheat-fields of Dakota and India, and the grazing-lands of Texas, Colorado, Australia, and the Argentine Republic, nearer to the factory operatives in Manchester, England, than the farms of Illinois were before the war to the spindles and looms of New England.

Changes in the Relations of Labor and Capital.—Consider next how potent for economic disturbance have been the changes in

* The average value of the wheat exported from the United States in 1885, according to the tables of the United States Bureau of Statistics, was 86 cents per bushel at the shipping ports. This was a decline of 20 cents from 1884, 26½ cents from 1883, 32 cents from 1882, 66 cents from 1874, and 61 cents from 1871.

The export value of corn was 54 cents in 1885, showing a decline of 7 cents from 1884, 14 cents from 1883, 12 cents from 1882, 30 cents from 1875, and 15 cents from 1872.

The export value of oats was 37 cents in 1885, showing a decline of 2 cents from 1884, 13 cents from 1883, 7 cents from 1882, 20 cents from 1875, and 14 cents from 1871.

The export price of bacon was 9 cents in 1885, showing a decline of 1 cent from 1884, 2 cents from 1883, 2 cents from 1875, a rise of 1 cent from 1872, and a decline of 6 cents from 1870.

The export price of lard was 7 cents in 1885, showing a decline of 2 cents from 1884, 4 cents from 1883, 6 cents from 1875, 3 cents from 1872, and 9 cents from 1870.

How closely the decline in recent years in the export prices of American cereals has been followed by corresponding reductions in the prices of cereals in the markets of Great Britain is exhibited by the following table (published in the British "Farmer's Almanac" for 1886), showing the average prices per quarter of wheat, barley, and oats, in Great Britain for two periods of ten years, commencing with 1865, with a separate estimate for 1885:

| Cereals. | Price per quarter. Average for the 10 years, 1866-1875. | Price per quarter. Average for the 10 years, 1876-1885. | Average price per quarter for 1885. |
|---|---|---|---|
| | s. d. | s. d. | s. d. |
| Wheat | 54 7¾ | 43 9¼ | 32 10 |
| Barley | 39 2 | 36 5 | 30 1 |
| Oats | 25 10½ | 22 8¼ | 20 7 |

Similar tables given by the same authority show the gross value per annum of the product of wheat, barley, oats, beef, mutton, and wool, in Great Britain, to have been £35,000,000 ($175,000,000) less in 1885 than were the mean returns for the ten years 1866–1875. According also to data given in the returns of the British Registrar-General, the average prices of beef by the carcass in the London market were £58 5*s.* 7*d.* per ton during the ten years from 1866–1875, £57 5*s.* 8*d.* for 1876–1885, and £49 17*s.* 6*d.* for the year 1885.

recent years in the relations of labor and capital, and how clearly and unmistakably these changes are consequents or derivatives from a more potent and antecedent agency.

Machinery is now recognized as essential to cheap production. Nobody can produce effectively and economically without it, and what was formerly known as domestic manufacture is now almost obsolete. But machinery is one of the most expensive of all products, and its extensive purchase and use require an amount of capital far beyond the capacity of the ordinary individual to furnish. There are very few men in the world possessed of an amount of wealth sufficient to individually construct and own an extensive line of railway or telegraph, a first-class steamship, or a great factory. It is also to be remembered that for carrying on production by the most modern and effective methods large capital is needed, not only for machinery, but also for the purchasing and carrying of extensive stocks of crude material and finished products. Sugar can now be, and generally is, refined at a profit of an eighth of a cent a pound, and sometimes as low as a sixteenth ; or in other words, from eight to sixteen pounds of raw sugar must now be treated in refining in order to make a cent ; from eight hundred to sixteen hundred pounds to make a dollar, from eighty thousand to one hundred and sixty thousand pounds to make a hundred dollars, and so on. The mere capital requisite for providing and carrying the raw material necessary for the successful prosecution of this business, apart from all other conditions, places it, therefore, of necessity beyond the reach of any ordinary capitalist or producer. It has been before stated that, in the manufacture of jewelry by machinery, one boy can make up nine thousand sleeve-buttons per day ; four girls also, working by modern methods, can put together in the same time eight thousand collar-buttons. But to run an establishment with such facilities the manufacturer must keep constantly in stock thirty thousand dollars' worth of cut ornamental stones, and a stock of cuff-buttons that represents nine thousand different designs and patterns. Hence from such conditions have grown up great corporations or stock companies, which are only forms of associated capital organized for effective use and protection. They are regarded to some extent as evils ; but they are necessary, as there is apparently no other way in which the work of production and distribution, in accordance with the requirements of the age, can be prosecuted. The rapidity, however, with which such combinations of capital are organizing for the purpose of promoting industrial and commercial undertakings on a scale heretofore wholly unprecedented, and the tendency they have to crystallize into something far more complex than what has been familiar to the public as corporations, with the impressive names of syndicates, trusts, etc., also constitute one of the remarkable features of modern business methods.

And when once a great association of capital has been effected, it becomes necessary to have a master-mind to manage it—a man who is competent to use and direct other men, who is fertile in expedient and quick to note and profit by any improvements in methods of production and variations in prices. Such a man is a general of industry, and corresponds in position and functions to the general of an army.

What, as a consequence, has happened to the employés? Coincident with and as a result of this change in the methods of production, the modern manufacturing system has been brought into a condition analogous to that of a military organization, in which the individual no longer works as independently as formerly, but as a private in the ranks, obeying orders, keeping step, as it were, to the tap of the drum, and having nothing to say as to the plan of his work, of its final completion, or of its ultimate use and distribution. In short, the people who work in the modern factory are, as a rule, taught to do one thing—to perform one and generally a simple operation, and, when there is no more of that kind of work to do, they are in a measure helpless. The result has been that the individualism or independence of the producer in manufacturing has been in a great degree destroyed, and with it has also in a great degree been destroyed the pride which the workman formerly took in his work—that fertility of resource, which formerly was a special characteristic of American workmen, and that element of skill that comes from long and varied practice and reflection and responsibility. Not many years ago every shoemaker was or could be his own employer. The boots and shoes passed directly from an individual producer to the consumer. Now this condition of things has passed away. Boots and shoes are made in large factories; and machinery has been so utilized, and the division of labor in connection with it has been carried to such an extent, that the process of making a shoe is said to be divided into sixty-four parts, or the shoemaker of to-day is only the sixty-fourth part of what a shoemaker once was.* It is also asserted that "the constant employment at one sixty-fourth part of a shoe not only offers no encouragement to mental activity, but dulls by its monotony the brain of the employé to such an extent that the power to think and reason is almost lost."

As the division of labor in manufacturing—more especially in the case of textiles—is increased, the tendency is to supplement the em-

* The following is a reported enumeration of the specialties or distinct branches of shoemaking at which men, women, and children are kept constantly at work in the most perfect of the modern shoe-factories, no apprentices being needed or taken in such establishments: "Binders, blockers, boot-liners, beaters-out, boot-turners, bottomers, buffers, burnishers, channelers, counter-makers, crimpers, cutters, dressers, edge-setters, eyeleters, finishers, fitters, heelers, lasters, levelers, machine-peggers, McKay stitchers, nailers, packers, parters, peggers, pressers, rosette-makers, siders, sandpaperers, skinners, stitchers, stringers, treers, trimmers, welters, buttonhole-makers, clampers, cleckers, closers, corders, embossers, gluers, inner sole-makers, lacers, leather-assorters, riveters, rollers, seam-rubbers, shank-pressers, shavers, slipper-liners, sole-leather-cutters, sole-quilters, stampers stiffeners, stock-fitters, strippers, taggers, tipmakers, turners, vampers, etc."

ployment of men with the labor of women and children. The whole number of employés in the cotton-mills of the United States, according to the census of 1880, was 172,544 ; of this number, 59,685 were men, and 112,859 women and children. In Massachusetts, out of 61,246 employés in the cotton-mills, 22,180 are males, 31,496 women, and 7,570 children. In the latter State certain manufacturing towns, owing to the disparity in the numbers of men and women employed, and in favor of the latter, are coming to be known by the appellation of "*she-towns.*" *

Another exceedingly interesting and developing feature of the new situation is, that as machinery has destroyed the handicrafts, and associated capital has placed individual capital at a disadvantage, so machinery and associated capital in turn guided by the same common influences, now war upon machinery and other associated capital. Thus, the now well-ascertained and accepted fact, based on long experience, that power is most economically applied when applied on the largest possible scale, is rapidly and inevitably leading to the concentration of manufacturing in the largest establishments, and the gradual extinction of those which are small. A cotton-mill which, with a profit (formerly not unusual) of a cent a yard, could easily pay ten per cent per annum on a given capital, with a reduction of profit to a quarter of a cent per yard, would have to make and sell four times the number of yards to earn the same gross profit, which even then would fall very far short of paying the former rate of percentage on the increased capital, machinery, buildings, etc., necessary to effect the increased production. Such also has already been, and such will continue to be, the outcome of railroad, telegraph, and steamship development and experience ; and another quarter of a century, unless legislation interferes, will not unlikely see all of the numerous companies that at present make up the vast railroad system of the United States consolidated, for sound economic reasons, under a comparatively few organizations or companies. In this respect the existing situation in Great Britain (which corresponds to that in all other countries) has thus been represented : "Trade after trade is monopolized, not necessarily by large

* "The tendency of late years is toward the employment of child-labor. We see men frequently thrown out of employment, owing to the spinning-mule being displaced by the ring-frame ; or children spinning yarn, which men used to spin. In the weave-shops, girls and women are preferable to men, so that we may reasonably expect that, in the not very distant future, all the cotton-manufacturing districts will be classed in the category of 'she-towns.' But people will naturally say, What will become of the men ? This is a question which it behooves manufacturers to take seriously into consideration, for men will not stay in any town or city where only their wives and children can be given employment. Therefore, a pause at the present time might be of untold value in the future, for, just as sure as the world goes round, women and children will seek fresh pastures, where work can be found for the husband and father, in preference to remaining in places where he has to play the part of the 'old woman,' while they go to work to earn the means of subsistence."—Wade's *Fiber and Fabric.*

capitalists, but by great capitals. In every trade the standard of necessary size, the minimum establishment that can hold its own in competition, is constantly and rapidly raised. The little men are ground out, and the littleness that dooms men to destruction waxes year by year. Of the (British) cotton-mills of the last century, a few here and there are standing, saved by local or other accidents, while their rivals have either grown to gigantic size or fallen into ruin. The survivors with steam substituted for water-power, with machinery twice or thrice renewed, are worked while they pay one half or one fourth per cent on their cost. The case of other textile manufactures is the same or stronger still. Steel and iron are yet more completely the monopoly of gigantic plants. The chemical trade was for a long time open to men of very moderate means. Recent inventions threaten to turn the plant that has cost millions to waste brick and old lead. Already nothing but a trade agreement, temporary in its nature, has prevented the closing of half the (chemical) factories of St. Helen's and Widnes, and the utter ruin of all the smaller owners. Every year the same thing happens in one or another of our minor industries."

Such changes in the direction of the concentration of production by machinery in large establishments are, moreover, in a certain and large sense, not voluntary on the part of the possessors and controllers of capital, but necessary or even compulsory. If an eighth or a sixteenth of a cent a pound is all the profit that competition and modern improvements will permit in the business of refining sugar, such business has got to be conducted on a large scale to admit of the realization of any profit. An establishment fitted up with all modern improvements and refining the absolutely large but comparatively small quantity, of a million pounds per annum, could realize, at a sixteenth of a cent a pound profit on its work, but $625. Accordingly, the successful refiner of sugars of to-day, in place of being as formerly a manufacturer exclusively, must now, as a condition of full success, be his own importer, do his own lighterage, own his own wharfs and warehouses, make his own barrels and boxes, prepare his own bone-black, and ever be ready to discard and replace his expensive machinery with every new improvement. But to do all this successfully requires not only the command of large capital, but of business qualifications of the very highest order—two conditions that but comparatively few can command. It is not, therefore, to be wondered at that, under the advent of these new conditions, one half of the sugar-refineries that were in operation in the seaboard cities of the United States in 1875 have since failed or discontinued operations.

The census returns of the United States are also very instructive on this point. Between 1850 and 1860, the number of manufacturing firms and corporations in the United States increased from 123,025 to 140,433, and the value of manufactured products increased from

$1,019,106,616 to $1,885,861,676, so that in that decade there was an increase of 17,408 establishments, to an increase of only $866,755,060 in the value of products. In 1870 there were 252,148 firms and corporations so employed, producing $4,232,325,442 in manufactured products ; or an increase of 111,715 establishments in the decade from 1860 to 1870, gave an increase of $2,346,461, in the value of products. In 1880, the number of manufacturing establishments was returned at 253,852, producing articles valued at $5,365,579,191, or an addition of only 1,704 firms and corporations was accompanied with an increase of product of $1,133,537,749. Here, then, is a demonstration that the average product of a manufacturing establishment in the United States in 1880 was just sixty per cent greater than it was in 1860.

The following are other illustrations pertinent to this subject: "It is a characteristic and noteworthy feature of banking in Germany," says the London "Statist," "that the bulk of the business is gradually shifting from the small bankers, who used to do a thriving business, to the great banking companies, leaving quite a number of small customers almost without any chance to prosper in legitimate operations—concentration of capital and business in the hands of a limited number of powerful customers being the rule of the day."

The tendency to discontinue the building and use of small vessels for ocean transportation, and the inability of such vessels to compete with vessels of larger tonnage, is shown by the statement that while a steamer of from 200 or 300 tons requires one sailor for every 19·8 tons, a steamer of from 800 to 1,000 tons requires but one sailor for every 41·5 tons. In like manner, while a sailing-vessel of from 200 to 300 tons requires one sailor for every 28·9 tons, a sailing-vessel of five times the size, or from 1,000 to 1,600 tons, requires but one sailor for every 60·3 tons. And as it is also claimed that other economies in the construction of the hull or the rigging, and in repairing, are concurrent with the reduction of crews, it is not difficult to understand why it is, that large vessels are enabled to earn a percentage of profit with rates of freight which, in the case of small vessels, would inevitably entail losses.

It was a matter of congratulation after the conclusion of the American war in 1865, that the large plantation system of cotton-raising would be broken up, and a system of smaller crops, by small and independent farmers or yeomanry, would take its place. Experience has not, however, verified this expectation ; but, on the contrary, has shown that it is doubtful whether any profit can accrue to a cultivator of cotton whose annual crop is less than fifty bales. "Cotton (at the South) is made an exclusive crop, because it can be sold for cash—for an actual and certain price in gold. It is a mere trifle to get eight or nine cents for a pound of cotton, but for a bale of 450 pounds it is $40. The bale of cotton is therefore a reward which the anxious farmer works for during an entire year, and for which he will spend half as much in money before the cotton is grown, besides all his labor and time. And the man who can not make eight or ten bales at least has almost no object in life, and nothing to live on."*

The (Milwaukee) "Directory of American Millers," for 1886, shows a decrease in the number of flour-mills in the United States for that year, as compared with 1884, of 6,812, out of a total in the latter year of 25,079, but an increase at the same time in capacity for flour production. The legitimate inference from these statistics, therefore, is, that the small flour-mills of the United States are being crushed, or forced into consolidation with the larger companies. That consolidation, in this instance, has not interfered with the cheapening of product, is indicated by the circumstance that whereas the mills of Minneapolis sent out in 1881 1,200,000 barrels of flour, at an average price of $6.14 per barrel, the quantity sent out in 1885 was 1,834,000 barrels, at an average of $4.89 per barrel; and for the year 1886 the average was reported at even less.

The experience of the co-operative societies of Great Britain—the inception and practical working of which have been hopefully looked upon as likely to furnish a solution of the labor problem—as recently detailed by Mr. Thomas Hughes ("Tom Brown"), does not, moreover, seem likely to constitute any exception to the general tendency of great aggregated capital, employed in production or distribution, to remorselessly disregard any sentiment on the part of the individual workman, in respect to his vocation, and to crush out or supersede all industrial enterprises of like character that may be compelled to work at relative disadvantage by reason of operating upon a smaller scale, or inability to employ a larger aggregate of capital. This experience, as related by Mr. Hughes at a recent Congress of the Co-operative Societies of Great Britain, has been as follows: Co-operation in Great Britain, so long as it has confined itself to distribution—that is, to the purchase of commodities at the lowest rates at wholesale and without the intervention of middle-men, and their subsequent sale to members of the societies at the minimum of cost and profit—has been a very great success; but co-operation in production, so far as it has been attempted by these same societies, appears to have succeeded only by abandoning co-operation in the original and best sense of the term. For example, some of the great and most successful co-operative distribution societies of England, in order to increase their dividends, have recently undertaken to manufacture a portion of the goods which they require, and thus secure for themselves the profits they have heretofore paid to the manufacturers; and with this view, the manufacture of boots and shoes has been commenced on a large scale by two of the largest of such societies in Glasgow and Manchester respectively—the English society employing a thousand operatives, and disposing of goods to a present aggregate value of more than a million dollars

* "Bradstreet's Journal."

per annum. "These manufacturing enterprises have not, however, been conducted on co-operative lines. . . . The work-people in their factories are not co-operators. They do not share in the profits of the business. They receive simply the market rate of wages." They are on just as bad terms with their co-operative employers as they would be with individual capitalists, and they have endeavored to better their condition by entering upon strikes; or, in other words, the great Co-operative Distribution Society managers, in Great Britain, finding that it was essential to their success as manufacturing producers, have adopted, without scruple, all the methods and rules that prevail in similar establishments which have been incorporated and are managed solely with a view to the profit of their individual capitalists or stockholders."

But this is not the whole story. Besides these great wholesale co-operative distribution societies which have engaged in manufacturing, there are a large number of smaller and weaker similar societies in Great Britain which are also attempting to manufacture the same description of goods for the profit of their more limited circle of members; and these last now complain that they are absolutely unable to withstand the competition of the larger wholesale societies, which, purchasing labor at the lowest rate in the open market, denying any participation of profit to their workmen, and working upon the largest scale, are enabled to produce and sell cheaper. "So that all the disastrous effects of unlimited and unscrupulous competition, for which co-operation was expected to be a cure, are showing themselves among the co-operators, and another example is to be added to the record of modern economic experience, of the strong industrial and commercial organizations devouring the weak."

An element of international character and importance, growing out of the improvements in production through machinery, should also not be overlooked. Whatever of advantage one country may have formerly enjoyed over another by reason of absolute or comparative low wages, is now, so far as the cost of machine-made goods is concerned, through the destruction of handicrafts, and the extended use and improvements in machinery, being rapidly reduced to a minimum. For, apart from any enhancement of cost by taxes upon imports, there is at present but very little difference in all countries of advanced civilization in the cost of machinery, of the power that moves it, or of the crude materials which it converts into manufactures. The machine, therefore, which enables the labor of one man to dispense with the cheap labor of ten men, practically reduces any advantage which the manufacturer in France, Germany, or other countries, paying nominally low wages, has heretofore had over the manufacturer of England, or of the United States, to the simple difference in the cost of the labor of the operative who manages the machine in different places; and all experience shows that the invariable concomitant of high wages, conjoined with the skillful management of machinery, is a low cost of production.

Attention is next asked to the economic—industrial, commercial, and financial—disturbances that have also resulted in recent years from changes, in the sense of improvements, in the details of the distribution of products. And as the best method of showing this, the recent course of trade in respect to the practical distribution and supply of one of the great articles of commerce, namely, tin-plate, is selected.

Before the days of the swift steamship and the telegraph, the business of distributing tin-plate for consumption in the United States was largely in the hands of one of the great mercantile firms of New York, who brought to it large enterprise and experience. At every place in the world where tin was produced and tin-plate manufactured, they had their confidential correspondent or agent, and every foreign mail brought to them exclusive and prompt returns of the state of the market. Those who dealt with such a firm dealt with them under conditions which, while not discriminating unfavorably to any buyer, were certainly extraordinarily favorable to the seller; and great fortunes were amassed. But to-day how stands that business? There is no man, however obscure he may be, who wants to know any morning the state of the tin-plate market in any part of the world, but can find it in the mercantile journals. If he wants to know more in detail, he joins a little syndicate for news, and then he can be put in possession of every transaction of importance that took place the day previous in Cornwall, Liverpool, in the Strait of Sunda, in Australia, or South America. What has been the result? There are no longer great warehouses where tin in large quantities and of all sizes, waiting for customers, is stored. The business has passed into the hands of men who do not own or manage stores. They have simply desks in offices. They go round and find who is going to use tin in the next six months. They hear of a railroad-bridge which is to be constructed; of a certain number of cars which are to be covered; that the salmon-canneries on the Columbia River or Puget's Sound are likely to require seventy thousand boxes of tin to pack the catch of this year, as compared with a requirement of sixty thousand last year (or in 1886)—a business, by-the-way, which a few years ago was not in existence—and they will go to the builders, contractors, or business managers, and say to them: "You will want at such a time so much tin. I will buy it for you at the lowest market price, not of New York, but of the world; and I will put it in your possession, in any part of the continent on a given day, and you shall cash the bill, and pay me a percentage commission"—possibly a fraction of one per cent; thus bringing a former great and complicated business of importing, warehousing, selling at wholesale and retail, and employing many middle-men, clerks, book-keepers, and large capital, to a mere commission business, which dispenses to a great extent with the employment of intermediates, and does not necessarily require the possession or control of any capital.

Let us next go one step farther, and see what has happened at the same time to the man whose business it has been not to sell, but to manufacture tin-plate into articles for domestic use, or for other consumption. Thirty or forty years ago, the tinman, whose occupation was mainly one of handicraft, was recognized as one of the leading and most skillful mechanics in every village, town, and city. His occupation has, however, now well-nigh passed away. For example, a townsman and a farmer desires a supply of milk-cans. He never thinks of going to his corner tinman, because he knows that in New York, and Chicago, and Philadelphia, and other large towns and cities, there is a special establishment fitted up with special machinery, which will make his can better and fifty per cent cheaper than he can have it made by hand in his own town. And so in regard to almost all the other articles which the tinman formerly made. He simply keeps a stock of machine-made goods, as a small merchant, and his business has come down from that of a general, comprehensive mechanic to little other than a tinker and mender of pots and pans. Where great quantities of tin-plate are required for a particular use, as, for example, the canning of salmon or lobsters, of biscuit, or of fruit and vegetables, the plates come direct from the manufactory to the manufacturer of cans or boxes, in such previously agreed upon sizes and shapes as will obviate any waste of material, and reduce to a minimum the time and labor necessary to adapt them to their respective uses. And by this arrangement alone, in one cracker (biscuit) bakery in the United States, consuming forty thousand tin boxes per month, forty men are now enabled to produce as large a product of boxes in a given time as formerly required fifty men; and, taken in connection with machinery, the labor of twenty-five men in the entire business has become equivalent to that of the fifty who until recently worked by other methods. And what has been thus affirmed of tin-plate might be equally affirmed of a great variety of other leading commodities; the blacksmith, for example, no longer making, but buying his horseshoes, nails, nuts, and bolts; the carpenter his doors, sash, blinds, and moldings; the wheelwright his spokes, hubs, and fellies; the harness-maker his straps, girths, and collars; the painter his paints ground and mixed, and so on; the change in methods of distribution and preparation for final consumption having been equally radical in almost every case, though varying somewhat in respect to particulars.

The same influences have also to a great degree revolutionized the nature of retail trade, which has been aptly described as, "until lately, the recourse of men whose character, skill, thrift, and ambition, won credit, and enabled them to dispense with large capital." Experience has shown that, under a good organization of clerks, shopmen, porters, and distributors, it costs much less proportionally to sell a large amount of goods than a small amount, and that the buyer of large quantities can, without sacrifice of satisfactory profit, afford to offer to his retail customers such advantages in respect to prices and range of selection, as almost to preclude competition on the part of dealers operating on a smaller scale, no matter how otherwise capable, honest, and diligent they may be. The various retail trades, in the cities and larger towns of all civilized countries, are accordingly being rapidly superseded by vast and skillfully organized establishments—and in Great Britain and Europe by co-operative associations—which can sell at little over wholesale prices a great variety of merchandise—dry-goods, manufactures of leather, books, stationery, furs, ready-made clothing, hats and caps, and sometimes groceries and hardware—and at the same time give their customers far greater conveniences than can be offered by the ordinary shopkeeper or tradesman. In London, the extension of the "tramway" or street-railroad system is even advocated, on the single ground that the big stores need quicker access to their branch establishments, in order to still further promote the economy of goods distribution.

The spirit of progress conjoined with capital, and having in view economy in distribution and the equalization of values, is therefore controlling and concentrating the business of retailing, in the same manner as the business of wholesale distribution and transportation, and of production by machinery, is being controlled and concentrated, and all to an extent never before known in the world's experience.

Keeping economy in distribution constantly in view as an essential for material progress, the tendency is also everywhere to dispense to the greatest extent with the "middle-man," and put the locomotive and the telegraph in his place. Retail grocers, as before shown, now buy their teas directly of the Chinaman, and dispense with the services of the East Indian merchant and his warehouses. Manufacturers deal more directly with retailers, with the result, it is claimed, of steadying supply and demand, and preventing the recurrence of business crises. The English cotton-spinner at Manchester now buys his raw cotton by cable in the interior towns of the cotton-growing States of North America, and dispenses with the services of the American broker or commission-merchant. European manufacturers now send their agents with samples of merchandise to almost every locality in America, Asia, and the Pacific islands, where commerce is protected and transportation practicable, and offer supplies, even in comparatively small quantities, on better terms than dealers and consumers can obtain from the established wholesale or retail merchants of their vicinity. And all of these changes have inevitably occasioned, and for a long time yet will continue to occasion, great disturbances in old methods, and entail losses of capital and displacement from occupation on the part of individuals. And yet the world wonders, and commissions of great states inquire without coming to definite conclusions, why trade and industry in recent years have been universally and abnormally disturbed and depressed.

## SLEEP AND ITS COUNTERFEITS.

By A. de WATTEVILLE, M.D.

THE Frenchman, whose long trance or sleep attracted extraordinary attention in the latter part of March and the beginning of April, was commonly spoken of as "the Soho sleeper"; but when we speak of a man "sleeping" for several days or weeks consecutively, it is obvious that we do not use the term in its ordinary sense. We all know by experience what sleep is, and we can not conceive ourselves as sleeping for an indefinite time. Yet it is difficult to draw a line between normal and abnormal sleep; the physiological condition merges by insensible degrees into all kinds of pathological states, known as lethargy, trance, stupor, coma. Through the usual phenomena of dreaming, we pass likewise into those of nightmare, somnambulism, hypnotism, ecstasy, and the like. Yet it is important sharply to define typical instances of these conditions, so as to avoid hopeless confusion in an already obscure field of scientific inquiry, and though we may for the sake of convenience occasionally use the term sleep in the wider sense, yet the distinction between the various states included under it must be kept present to our minds.

From the immense number of strange phenomena observed at the Salpêtrière Hospital in Paris, where this subject of *hypnotism*, especially in hysterical patients, has been investigated with the greatest care, and where I have had the opportunity of studying it, I shall adduce only such instances as have a direct bearing upon the case of "the Soho sleeper."

It is often possible to distinguish between a somnambulistic, a lethargic, and a cataleptic condition of the hypnotized hysterical subject; and by appropriate manipulations (all based on the theory of influencing the brain-centers by sensory impressions) to make the subject pass from one to another of these states. Supposing we have, by intently staring or by "passes," induced the *lethargic* state, we find that the muscles and nerves of the subject are in a state of extreme hyper-excitability. If we press through the skin with the finger, or a pencil, upon a nerve-trunk, all the muscles supplied by that nerve are instantly thrown into a state of violent contraction. This contraction, strange to say, may, if unchecked, persist not only during the whole of the period of lethargy, but may last for hours, or even days, after the patient has awoke, and does not then relax even during the interval of normal sleep. On the other hand, the rigidity immediately gives way under the influence of gentle stroking of the skin over the contracted muscles.

By *catalepsy* is meant a condition of suspended psychical manifestations on the part of the subject, during which the limbs exhibit no muscular or nervous hyper-excitability, but possess the singular property, while remaining flexible, of preserving indefinitely any attitude imparted to them; hence the name of "waxy flexibility" given to this condition by old writers. Unlike the rigid spasms of the lethargic muscle, the plastic fixity of the cataleptic limb can not be relaxed by friction over the skin. The aspect of the patient in the two conditions, moreover, offers striking differences, the sleep-like immobility of lethargy contrasting vividly with the petrified attitudes of catalepsy. In both conditions, however, there often is the same absolute insensibility even to the most painful stimuli. A most remarkable phenomenon may be observed in some instances: by merely opening one eye of the lethargic patient the corresponding side of the body is cataleptized. And so in the same subject these two phases of the hypnotic sleep may coexist side by side, with the fullest display of their contrasted characteristics.

The third condition, that of *somnambulism*, may easily be brought about by light pressure or rubbing on the top of the head. The hysterical patient then passes into a state somewhat between the lethargic and the cataleptic condition. The muscles have lost the hyper-excitability of the former state, and do not possess the plastic adaptability of the latter. Still they react abnormally to light external stimuli; if we very gently stroke or blow upon a limb, it becomes somewhat rigid. We can not then relax it by a mere touch as we can in lethargy, and, unlike catalepsy, it offers some resistance when we attempt to move it into a different attitude. Insensibility to pain may persist, but there often is in the somnambulistic phase a singular exaltation of memory and of sensorial perception, which has caused it to be called the "lucid state," and which has been described by the devotees of mesmeric delusions as "second-sight." Our readers will recognize in this description the ordinary "magnetic" or "mesmeric" sleep into which not only hysterical, but many other individuals may be more or less completely plunged by the usual "passes" of operators.

It is especially in the somnambulistic state that the astonishing phenomena of *suggestion* are observed. By this we mean that the patient in whom every spontaneity is in abeyance, who does not "sleep," and who yet does not move or think, can be so impressed through some sensory channel as to enter upon some definite train of ideas or movements. He is under the control of the experimenter, whose will is his will, so to speak. He is a machine ready to go, but unable to start of itself.

There are many different ways of imparting suggestions to a hypnotized subject; and as, in the other phases of hypnotism, hysterical patients present the greatest variety of manifestations, when subjected to suggestive influences. The most characteristic phenomena are those known as "muscular" suggestions. If we analyze an emotional attitude, such as that of sending kisses to a loved person, or that of threatening an enemy with the fist and outstretched arm, we notice that the whole frame takes part in the special action. The eyes dilate, the muscles of the face move, and an appropriate play of the features accompanies the leading gesture. This collaboration of several parts of the body in the production of a common effect depends upon the existence in our nervous system of certain mechanisms subservient to the function of mimetic language or physical expression. Now if in the hypnotized subject we throw a limb into such an expressive attitude, we immediately see the usual concomitants of the movement follow suit; the trunk and other limbs fall into a harmonious posture, the carriage of the head is modified likewise, and the expression assumed by the face and eyes is so perfect as to equal or surpass the best efforts of the most consummate actor. It is difficult for any one who has not witnessed the spectacle to realize the perfection of mimicry reached by the hypnotized hystero-epileptic. The cause of this phenomenon is not far to seek: the impression conveyed by the nerves from the part placed in the attitude has called into action the whole nervous mechanism presiding over the movements generally associated with this attitude. But this is not all. Duchesne has analyzed minutely the anatomy of the expression of the human face, and by means of electric currents localized in certain muscles or combinations of muscles, imitated with great success the facial play indicative of the various emotions and feelings of the mind. Now if in our subject we likewise electrically stimulate certain muscles, and artificially produce an expression of anger, or terror, or love, or disdain, the corresponding attitude is at once assumed by the neck, arms, and body generally. Those of our readers who have access to the book will find remarkable illustrations of these phenomena in Dr. Richer's beautiful work,* for the accuracy of which all those who have had the opportunity of studying hypnotic manifestations in hystero-epileptics will be ready to vouch.

Whole series of muscular actions may be initiated by appealing to the so-called "muscular sense" by similar methods of suggestion. Thus, if a hanging rope is placed in the hands of the patient, she begins to climb with incredible energy and alacrity; when placed on all-fours, she runs in that position all over the room, regardless of knocks and collisions. Or, if the movements of washing with invisible soap be communicated to her hands, she will persist in the mimicry for an indefinite time. It is sometimes difficult to check an action so started

* "Études Cliniques sur la Grande Hystérie," second edition, p. 668.

except by waking the patient up, or making her pass into lethargy. The hypnotized patient therefore is much in the state of the frog, which when thrown into a pond, even after its brain has been removed, begins to swim on touching the water, aimlessly, automatically.

Sometimes a movement repeatedly executed by the operator in front of the patient will be imitated and carried out by the patient until stopped: this is a case of suggestion through the organ of sight. Or more complicated trains of movement may be initiated by presenting to the patient objects suggestive of certain actions, such as a plate and spoon, a brush and comb, and the like. The sight of a boot will start an endless repetition of putting it on, lacing and unlacing, taking it off, putting it on again, and so forth indefinitely.

The field of suggestions through the ear by means of language is boundless. Such words as "rats," "bird," "flower," wake up a train of imagery in the patient's brain which is immediately projected outward in an expressive display of appropriate gestures of aversion or desire, and corresponding movements of avoidance or capture. If in deep hypnotism, the subject is immediately wrapped up in those creations of the imagination; if slightly hypnotized only, repetition of the suggestive words is needed to neutralize the controlling influence of the senses. The ordinary phenomenon of hypnotism, the impossibility which the subject feels of escaping the prohibiting influence of a suggestion, belongs to this category. You assure him that he can not move his arm, for instance; he feels that he can, and yet he can not. The volitional current from his higher brain-centers is neutralized, as it were, by the current from other centers in which the suggestion has created a fixed idea of his own incapacity. As hypnosis becomes deeper, every trace of resistance disappears, and the fixed idea reigns supreme.

Such are the leading phenomena of hypnotism as observed in those highly sensitive subjects, the sufferers from the graver form of hysteria, or hystero-epilepsy. It would take us too far to describe the various symptoms of this form of nervous derangement, which, though comparatively common in France and among certain other nations, seems to be very rare, at least in its full development, among the Germanic races. In Dr. Richer's work, already mentioned, a full account is given of the appalling violence of the convulsive seizures and of the delirium that characterize the disease. Epidemics of hystero-epilepsy were rife in the middle ages, especially among the members of religious bodies; and even now it seems to be closely related to superstitions or mystical beliefs and practices.

Though essentially a disease of the female nervous organization, many instances are found of men suffering from more or less modified forms of hystero-epilepsy. The less striking symptoms of it, such as various forms of paralysis, loss of sensation, loss of speech (aphasia), are often sufficiently developed in male subjects to justify us in classing them in the hysterical category of nerve-sufferers.

In this category "the Soho sleeper" deserves to hold a high place, as will become manifest on reading the following condensed *résumé* of his history as given by Professor Charcot, in the "Progrès Médical" for March, 1886, and completed by some further details, published in recent numbers of the "British Medical Journal":

Ch. was born in 1848, and his family history points to a strong neurotic heredity. He served in the French army in Algeria; and during the Franco-German War received a wound in the left elbow which led to amputation of the arm (1871). A few months later he was seized while at supper with unconquerable drowsiness, from which he could not be aroused. The next morning he broke out into a terrific delirium that lasted two days. A second attack of a similar nature occurred soon after. In 1875 he suffered from strange nervous symptoms, and in 1878 had another attack of sleep, followed by a long period of imperfect articulation. In 1880 he was seized again; and in addition to complete loss of speech, there was loss of feeling and movement of the left leg. He remained six months under treatment. Since then there has been a series of relapses, after one of which (1885) he came under the notice of Professor Charcot in the Salpêtrière Hospital. He was then found to have lost to a great extent sensation on the left side of the body; he could not articulate a single sound, but could express himself freely by writing. He was troubled with nightmare, in which the hallucinations of his former delirious seizures used to recur. He recovered his speech quite suddenly, without passing through a period of stammering as on former occasions.

During the fifteen months that elapsed till his arrival in London, he seems several times to have gone through his usual ordeal of sleep, followed by loss of speech and paralysis of the left leg. The attack which he has just had, seems to have been excited by the emotion he experienced on being robbed of all his money (March 24th). The somnolent stage lasted about a fortnight, and was followed with the usual paralytic and aphasic condition. During his torpor his eyes were shut, and his general appearance was that of a man in a profound sleep. He did not react to the loudest sounds; but if a ray of light was cast upon the pupil the eyelids gradually opened, and the eyeballs converged toward the bright object. The results of various experiments made upon the patient in his trance-like state illustrate several of the hypnotic phenomena already described as observed in hystero-epileptic patients. His muscles presented both the hyper-excitable and the plastic peculiarities that characterize the lethargic and the cataleptic phases respectively of artificially-induced sleep, but with the difference that they both coexisted, whether the eyes were shut or opened. Certain phenomena of suggestion through the "muscular sense" could easily be elicited. For instance, a series of movements imparted to the face, arm, or leg was automatically repeated, and continued for an indefinite time. Again, on imparting to his upper extremity an attitude of menace with outstretched arm and clinched fist, his eyes (previously opened) suddenly turned toward the limb, and he assumed an expression of anger verging on ferocity. I noticed that on interposing an opaque object between the eyes and the arm, the latter speedily relaxed and fell, the eyes closed, and the patient relapsed into his accustomed slumber.

During the second week of the trance he began to obey orders repeatedly given, such as "Open your eyes," "Sit up," etc., and to answer simple questions by writing. He could be made to write anything to dictation; but whenever ordered to indite a letter, he constantly reproduced one he had written shortly before this attack.

Finally, he was found to have lost sensation in the left side; and the application of magnets to the skin produced some of the alterations of feeling characteristic of hysterical hemianæsthesia. Powerful electrization, though it failed to rouse him up, induced convulsions and spasms, typical of the regular hystero-epilectic seizure.

There is thus no doubt left us as to the nature of the case of "the Soho sleeper." Among other instances of attacks of sleep in the course of hystero-epilepsy, I may mention a patient whom Professor Charcot has had under his observation for many years:

She first came to the Salpêtrière Hospital in 1862, and presented many of the alterations of sensation and movement characteristic of the disorder. On April 7, 1875, she was seized with somnolency, which persisted with temporary awakenings till the 27th. There occurred then a violent outburst of paroxysmal laughter and weeping. From that moment the patient passed into a cataleptic condition, with occasional hysterical fits of the same description. She had to be fed with a spoon; she swallowed as if automatically, with a noise, but without any signs of consciousness. She awoke quite abruptly on the 7th of June, and affirmed that she had no recollection of what had taken place during the past two months. There occurred in 1876 another fit of the same kind, that lasted about a fortnight.

In order to illustrate further the intimate connection between certain morbid forms of sleep and the hysterical state, I shall briefly allude to the so-called "hysterogenic" and "hypnogenic" pressure-points discovered by Professors Charcot and Pitres.

A very remarkable phenomenon connected with grave hysteria is the artificial production and arrest of attacks by pressure on certain points on the surface of the body. The number and distribution of these points are very variable, and they differ in every case. They usually can only be found out by careful search, the patients themselves ignoring the existence of them.

On pressure being exerted upon one of these "hysterogenic" spots, the patient falls into a convulsive or tetanic spasm, and the various phases of the attack succeed one another much in the same order as in a spontaneous fit. Now it is a curious fact that a repetition of the pressure on the same spot, or on some other spot experimentally discovered, will often abruptly modify or arrest the attack. The great theoretical and practical importance of this singular property of certain circumscribed cutaneous areas, has directed the investigations of several careful observers, and led to the discovery of similar spots, called "hypnogenic," pressure upon which determines, not a muscular spasm or convulsion, but an attack of hypnotic sleep.

These hypnogenic areas are likewise irregular in their number and distribution ; and along with them are usually found other spots, usually on the opposite side of the body, pressure upon which awakes the patient. We have here an undoubted argument in favor of the view according to which attacks of sleep in certain hystero-epileptics are mere modifications of the typical convulsive and delirious seizure.

The researches of Althaus have led him to formulate the axiom that "nervous diseases are not, as is commonly asserted, more frequent, but on the contrary less numerous, in large towns than in the country, and it is probable that their occurrence is powerfully influenced by race." He adduces a table in which the percentages of deaths from nervous diseases (as recorded in the Registrar-General's returns) for London, the southwestern counties, and Wales are 10·66, 11·20, 15·38, respectively. He has found that "Wales exceeds all English counties so strikingly in this respect that neither density of population, nor climate, nor difference of occupation will account for that circumstance." He is therefore inclined to attribute this difference to another circumstance, viz., the difference of race—a conclusion that is borne out in a certain measure by the undoubted greater prevalence of hysteroid symptoms among the Latin, and perhaps also the Slav and other Eastern races, as compared with those of Germanic origin.

It is probably in considerations of this nature that we shall find an answer to the question often asked in this country by those who do not roundly attribute all or most of the symptoms of hystero-epilepsy to shamming or exaggeration, "How is it that such cases never come to our notice?" Is it not because of those racial differences which run deep in the nervous constitution of individuals? At any rate the presence of "the Soho sleeper" among us will, let us hope, modify the somewhat insular skepticism still lurking among medical men on this side of the Channel.

The subject of prolonged sleep and trance is intimately connected with that of apparent death. Though there is no doubt that most of the dreadful tales concerning the premature burial of persons supposed to be dead have no foundation, save in the imagination of the public, we have ample proof of the possibility of such mistakes occurring in the absence of a careful examination of the body. Every one has heard of the fatal tragedy in which the greatest anatomist of his time, Vesalius, played such an unfortunate part. Being called upon, during his stay in Spain, to perform the autopsy of a patient who had died suddenly, he proceeded to open the body, when, to the horror of the bystanders, at the second sweep of the knife unmistakable signs of life were given!

It is difficult to imagine how in the case of patients subject to cataleptic seizures, and known by their friends to be so, periods of suspended animation, however protracted, could ever lead to premature burial. Pfendler, however, states, that he has known two cases in which a disastrous result was barely averted:

> A Viennese lady, who had suffered for a long time from cataleptic or lethargic attacks, was finally buried in one of her trances. The sexton, who fortunately happened to be a thief in this instance, had reopened the grave, and was busy removing her clothes during the ensuing night, when a resurrection of the dead took place. Stricken with terror, he was running away, when the woman called him back, requesting to be taken to her doctor. The second instance referred to by Pfendler is that of a young lady, aged fifteen, who, after a convulsive attack, had St. Vitus's dance and other nervous symptoms. Finally she became subject to fits of sleep lasting several days. Her health suffered greatly, and the exhaustion became such that, after a consultation of the first physicians, every hope of her recovery was given up. The next day she suddenly started as if to embrace the attendant who was watching her, and fell back as if dead. All the usual tests failed to detect any sign of life. Finally, funeral preparations were made; she was dressed in white, the bell was tolling. Still uneasy about the absence of any sign of decomposition, Pfendler was making a last examination when he detected a faint respiratory movement. After an hour and a half's friction and stimulation, movement returned; and the patient looking about and smiling said, "I am too young to die." She then fell into a sleep of ten hours' duration, and woke up in full convalescence. The patient in this case had never lost consciousness, and remembered afterward what had been said and done in the room during the medical consultation and funeral preparations.

Catalepsy, though intimately allied to hysterical neurosis, often occurs in patients who offer no other symptoms of nervous derangement. Emotions are often the exciting cause of an attack in a cataleptic subject. Many curious instances are related by authors:

> A little girl, mentioned by Tissot, shocked at her sister having helped herself to a coveted morsel, remained stiff and motionless for an hour, a spoon in her hand, and her arm outstretched toward the dish. A soldier, quarreling with a companion, in a fit of passion seized a bottle to throw at him; cataleptic rigidity fixed him in this attitude, motionless, unconscious, his eyes full of anger and defiance. In another case, a magistrate on the bench, insulted in the middle of his summing up, remained as if petrified in an attitude of indignation and threat at his insulter. Again, we read of priests being cataleptized at the altar in the attitude of elevating the sacrament.

It is certain that many of the saintly women in the Roman Catholic hagiology were victims of this disease: St. Catherine of Siena, St. Elizabeth of Hungary, St. Theresa; not to speak of Joan of Arc, Madame Guyon, Marie Alacoque, and many others. Cataleptic seizures were also a common feature among the victims of the great hystero-epileptic manifestations so common in the middle ages, which we find described as "possessions" in the curious and abundant literature of the subject.

Among the sickening descriptions of the awful episodes known as "the possession of the Ursulines of Loudun," we find a graphic description of cataleptic phenomena:

The devil, enemy of Sister Claire, appeared at the command of her ordinary exorcist, Father Elizée, and rendered her supple and ductile like a sheet of lead. The exorcist bent her body in various directions—forward, backward, laterally—so that she almost touched the ground with her head. The demon kept her in the posture in which she had been placed until she was moved again, during which time she only slightly breathed through the nose and was insensible, for the father pierced a fold of her skin with a pin without drawing blood or producing pain. We also read of others who were "remarkable for their pliability. In their sleep they could be manipulated like a sheet of lead, and preserved the postures imparted to them until moved again." Elsewhere a nun possessed by the demon Cismond lay on the ground in a strange trance; her arms and legs could be twisted about as if made of wool; nothing could be extracted from her; the devil keeping her in this condition so as to prevent her confession.

Though, as already mentioned, the Latin races appear to offer a much more favorable field for the spread of nervous epidemics, we read that England has not always been free from such manifestations:

"During Wesley's sermons at Bristol," says Dr. John Chapman, in his work "On Christian Revivals, their History and Natural History," "many used to fall as if struck to the heart by the word of God. Men and women by the score were lying on the ground, insensible like dead bodies." Singular nervous accidents were likewise frequent among the American fanatics known as Shakers or Jumpers, as well as among the Irish revivalists of Ballymena.

As late as 1861, at the village of Morzine, a secluded commune in the Alps of Savoy, there occurred a curious epidemic of hysteria with all the characters of "demoniacal possession." The population of these regions is extremely neurotic and superstitious. In a short time nearly all the female population, excited by the exorcismal practices of the clergy, fell a prey to the disease, and the scenes recalled the worst days of Loudun. But at the beginning, when young girls were chiefly affected, phenomena of ecstasy, catalepsy, and somnambulism prevailed. The Government had finally to interfere, and the temporary dispersion and seclusion of the patients speedily restored their mental equilibrium, and the locality has since resumed its habitual tranquillity.

As an instance of trances of a more contemplative tendency, I shall give a short account of Louisa Lateau, of whose attacks Dr. Lefebvre has given a good description:

She used to pass into that condition without any warning. Suddenly, during a conversation, or at her sewing-machine, she would become as if transfixed, the eyes turned upward to the light. "Her expression is then one of deep attention or of distant contemplation. Her physiognomy, like her attitude, often changes, and depicts feelings of joy or of sadness. Sometimes terror is expressed, or she turns slowly, as if watching the progress of an imaginary procession. Sometimes she stands, resting on the tips of her toes, with her hands outstretched, as if to fly away. Her lips move, the eyes brighten, and her face is illuminated by an ideal beauty. The stigmata in her forehead and hands bleed.

. . . She kneels, falls face forward to the ground, where she remains for hours in the attitude of crucifixion. Other attitudes are taken during the ecstatic condition, which comes to an end in the midst of alarming symptoms of impending death."

I will, in conclusion, venture upon a few suggestions as to the explanation of the phenomena of hypnotism and its allied states.

Our cerebral life depends upon the associated activity of innumerable nerve-cells grouped into clusters or centers, each center being more directly related with some sensory or some motor function. Thus there are visual centers, auditory centers, tactile centers, which form the terminal stations of the nerve-fibers leading from the organs of sight, hearing, and touch. There are also so-called motor centers, the nervous discharges from which, traveling down to the spinal cord, determine movements of the head, trunk, and limbs.

A network of the finest nerve-fibrils of astounding complexity brings the individual cells of each center into relationship with one another, and with the cells of the other centers. This physical association of our brain-elements is the material substratum of the psychical process of association of ideas which forms the groundwork of our intellectual life. All the higher manifestations of mind are correlatives of the harmonious co-operation of numerous brain-elements. Even what appear to be simple states of consciousness are often the result of association. Hence any disturbance in the mutual equilibrium of the cerebral centers speedily leads to alterations of those resultants of forces of which perception, thought, will, emotion, are the subjective manifestations.

One of the most striking properties of the nervous system is that by which the activity of one portion may be arrested or prevented—"inhibited"—by the activity of another. To give a familiar instance, the action of the respiratory centers is suddenly inhibited by certain excitations of the sensory nerves, as we have all experienced on receiving the first splash of a cold shower-bath. In the cerebral sphere, inhibition of one tract by another is the mechanism which lies at the root of the higher exercise of our faculties. When we choose, for instance, or exercise will-power, the corresponding state of our nervous organism is one involving more or less complex inhibitions. The sense of moral effort is the subjective equivalent of powerful inhibitions of brain-tracts in a state of high tension. The power of mental concentration rests likewise upon similar inhibitions. When we attend closely to a sensory impression, or to a train of thought, the excitability of every part of the brain except that actually engaged in the act is diminished by an inhibitory action of the working portion. Thus, when wo say that anger or fear paralyzes, we allude in very accurate language to the inhibitory influence which powerful emotion exercises upon the other cerebral functions.

I have said that physiological sleep can be induced by certain monotonous impressions from without. The same may be said of an order of stimuli that has hitherto not received its due share of attention. I mean the afflux of those confused, mostly unfelt, impressions from the viscera and tissues generally. Under certain conditions—after a meal, for instance—these may set up, in the cerebral centers to which they converge, an excitation that leads to an inhibition of the higher brain-regions, and so to a state of sleep.

Similar considerations will assist us in explaining the effect of the usual methods of hypnotization. The stimulation of one of the cerebral sensory centers by repeated gentle and monotonous sounds or touches, or, in the case of the visual organs, by the convergence of the eyes and persistent gazing at a small object, so interferes with the activity of the higher centers as to lead to various perverted motor and mental manifestations. Certain "nervous" individuals, but above all hysterical subjects, are more amenable to these effects than are others. Repetition in all cases increases the liability to hypnotization, and in extreme cases the recollection of the processes previously used becomes sufficient to induce sleep. Finally, there are subjects, such as "the Soho sleeper," in whom, owing to the extreme instability of their cerebral equilibrium, a kind of spontaneous hypnotization may be observed.

It would be premature, in the actual state of our knowledge, to speculate upon the nature of the changes in the nervous system upon which the phenomenon of inhibition depends. It has been ingeniously compared to that of the mutual *interference* of two rays of light or two waves of sound. But this analogy does not account for all the facts ; and in connection with this topic we may mention the views recently propounded by Professor Brown-Séquard upon what he calls nervous "dynamogeny." It is a well-known fact that under the influence of various sensorial or emotional stimuli, of moderate intensity or pleasurable quality, our nervous energy, as measured by the muscular effort we are enabled to put forth, is increased to a considerable extent. Recent researches by Dr. Féré have thrown additional light upon these "dynamogenic" or "force-producing" processes, of which the reviving effect of smelling-salts is a familiar illustration. In this instance a diffusive wave invades the whole brain from the olfactory centers, and produces such a change in its constituents as to restore its functions. It has likewise been shown that every form of mental activity is accompanied with increased nerve-power as directly measured by the squeeze of the hand on the dynamometer. It would thus seem that nervous cell-matter is liable to undergo certain modifications under the influence of various impressions derived from other nerve-regions, in virtue of which it becomes more powerful. But, without even attempting to define more closely the "dynamogenic" change, we may perhaps assume it to be the counterpart of what takes place in inhibition, and describe the latter as a nervous process in which a group of nerve-cells so acts upon another group as to lower its capacity for work.

Inhibition in one nervous sphere is often accompanied with dynamogeny in another: the removal of cerebral influence, for instance, exalts the autonomy of the spinal cord. A good instance of the coexistence of the two processes is found in "expectant attention," which depends upon the high tension of the centers involved in anticipating the phenomena, with a corresponding inertia of the others. The reader will readily perceive how similar considerations may be employed in the elucidation of such phenomena as ecstasy, suggestion, muscular hyper-excitability, and intensified perception.—*Fortnightly Review.*

## INDUSTRIAL TRAINING TWO CENTURIES AGO.

By GEORGE P. MORRIS.

AN Industrial College has just been opened in the city of New York. The State Teachers' Association of New Jersey, at its recent session, devoted some time to the discussion of the question of "Manual Instruction." Almost every one of the current magazines has monthly contributions from prominent instructors, shedding new light upon this question of the coming education. So much in order to prove the timeliness of the following reference to the past.

Thomas Budd arrived in Burlington, New Jersey, in 1678. His father was the Rev. Thomas Budd, at one time rector of the parish of Martock, Somersetshire, England, but who forsook the state Church and became a follower of George Fox, and an ardent Quaker. Arriving in Burlington, Budd immediately assumed the rank of a leading citizen in that wonderful colony of West Jersey. If any doubt the propriety of the adjective *wonderful*, let them read Bancroft's tribute to the Quakers of West Jersey, and the laws which governed and the habits which distinguished them.

In 1683 Budd and Francis Collins were each granted a large tract of land near the Falls of Trenton, "in consideration and in discharge for building the market and court-house at Burlington." In 1684, in company with Samuel Jenings, Budd went to London to confer with Edward Byllinge about the affairs of the province. In 1685 he became a citizen and merchant of Philadelphia. In 1688 his name is found among the petitioners for a bank in that city. In the great controversy between George Keith and the Quakers, Budd espoused the cause of Keith, whose intimate friend he was, and in 1694 went with Keith to England to defend him before the yearly meeting. In 1685 Budd wrote and published "a small Treatise," the title-page bearing the following peculiar inscription and dedication:

GOOD ORDER ESTABLISHED
IN
PENNSILVANIA & NEW JERSEY
IN
AMERICA,

Being a true Account of the Country;
With the Produce and Commodities there made,
And the great Improvements that may be made
by means of Publick Store-houses for Hemp,
Flax and Linnen-Cloth; also, the Advantages of a
Publick-School, the Profits of a Publick-Bank,
and the Probability of its arising, if those
directions here laid down are followed. With
the advantages of publick Granaries.
Likewise several other things needful to be understood by those that are or do intend to be
concerned in the planting in the said Countries,
All which is laid down very plain, in this small
Treatise; it being easie to be understood
by any Ordinary Capacity. To which the Reader
is referred for his further satisfaction.

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BY THOMAS BUDD.

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*Printed in the Year 1685.*

Those that have generous Spirits, whose desires and
Endeavours are to bring the Creation into Order, do
I dedicate This, the first Fruits of my Endeavours.

Authorities differ as to the place of publication. It is commonly said to have been printed in London while Budd and Jenings were there upon their mission as deputies of the province. Others assert that it was one of the publications of the well-known William Bradford, of Philadelphia, and give reasons why it could not have been printed in London, and why Bradford omitted to insert his name as publisher.

In this treatise Budd describes, first, the physical features of the two provinces—East and West Jersey—the prevailing social customs; and then, after giving wholesome advice to the farmers, brewers, manufacturers, and tanners, and after outlining a scheme by which public storehouses might be built with profit to the community, and describing the ways by which the industry of flax and hemp might be encouraged, he gives his readers what he deems to be the proper system of education. His conclusion is that, if this system of education is adopted and prevails, then not only will the minds and bodies of the youths be properly developed, but the public and private coffers will be enriched. We quote so much of the treatise as deals with the subject of education. He writes:

"1. Now It might be well if a Law were made by the Governours and General Assemblies of Pennsilvania and New Jersey, that all Persons inhabiting in the said Provinces do put their Children seven years to the publick School, or longer, if the Parents please.

"2. That Schools be provided in all Towns and Cities, and Persons of known honesty, skill, and understanding, be yearly chosen by the Governour and General Assembly, to teach and instruct Boys and Girls in all the most useful Arts and Sciences that they in their youthful capacities may be capable to understand, as the learning to Read and Write true English, Latine, and other useful Speeches and Languages, and fair Writing, Arithmatick, and Book-keeping; and the Boys to be taught and instructed in some Mystery or Trade, as the making of Mathematical Instruments, Joynery, Turnery, the making of Clocks and Watches, Weaving, Shoemaking, or any other useful Trade or Mystery that the School is capable of teaching, and the Girls to be taught and instructed in Spinning of Flax and Wool, and Knitting of Gloves and Stockings, Sewing, and making of all sorts of useful Needle-Work, and the making of Straw-Work, as Hats, Baskets, &c., or any other useful Art or Mystery that the School is capable of teaching.

"3. That the Scholars be kept in the Morning two hours at Reading, Writing, Book-keeping, &c., and the other two hours at work in that Art, Mystery or Trade that he or she *most delighteth in;* and then let them have two hours to dine and for Recreation, and in the afternoon two hours at Reading, Writing, &c., and the other two hours at work at their several Imployments.

"4. The seventh day of the Week the Scholars may come to school only in the fore-noon, and at a certain hour in the afternoon let a Meeting be kept by the Schoolmasters and their Scholars, where after good instruction and admonition is given by the Masters to the Scholars, and thanks returned to the Lord for his Mercies and Blessings that are daily received from him, then let a strict examination be made by the Masters of the Conversation of the Scholars in the week past, and let reproof, admonition, and correction be given to the Offendors, according to the quantity and quality of their faults.

"5. Let the like Meetings be kept by the School-Mistrisses, and the Girls apart from the Boys. By strictly observing this Good Order, our Children will be hindred of running into that Excess of Riot and Wickedness that youth is incident to, and they will be a comfort to their tender Parents.

"6. Let one thousand Acres of Land be given and laid out in a good place, to every publick School that shall be set up, and the Rent or incom of it go towards the defraying of the charge of the School.

"7. And to the end that the Children of poor People and the Children of Indians may have the like good Learning with the Children of Rich People, let them be maintained free of charge to their Parents, out of the Profits of the school, arising by the Work of the Scholars by which the Poor and the Indians as well as the Rich, will have their Children taught, and the Remainder of the Profits, if any be, to be disposed of to the building of School-houses, and Improvements on the thousand Acres of Land, which belongs to the School."

"The manner and Profits of a Spinning-School in Germany, as it is laid down by Andrew Yarenton in his own words, in a book of his call'd 'England's Improvements by Sea and Land,' take as followeth: 'In Germany, where the Thred is made that makes the fine Linnens, in all Towns there are Schools for little Girls, from six years old and upwards, to teach them to spin, and so to bring their tender fingers by degrees to spin very fine; their Wheels go all by the Foot, made to go with much ease, whereby the action or motion is very easie and delightful. The way, method, rule, and order, how they are governed is: 1st. There is a large Room, and in the middle thereof a little Box like a Pulpit: 2ndly. There are Benches built around about the Room, as they are in Play-houses; upon the benches sit about two hundred Children spinning, and in the box in the middle of the Room, sits the grand-Mistress with a long white Wand in her hand; if she observe any of them idle, she reaches them a tap, but if they will not do, she rings a bell, which by a little Cord is fixed to the box, and out comes a Woman, she then points to the Offendor, and she is taken away into another Room and chastized; and all this is done without one word speaking. In a little Room by the School there is a Woman that is preparing and putting Flax on the Distaffs, and, upon the ringing of a Bell, and pointing the Rod at the Maid that hath spun off her Flax, she hath another Distaff given her and her Spool of Thred taken from her, and put into a box unto others of the same size, to make Cloth, all being of equal Threds. 1st. They raise their Children as they spin finer, to the higher Benches. 2. They sort and size all the Threds, so that they can apply them to make equal Cloths; and after a young Maid hath been three years in the Spinning-School, that is taken in at six, and then continues until nine years, she will get eight pence the day, and in these parts I speak of, a man that has most Children lives best.'"

It will be readily seen that this scheme of Budd's is very like that proposed to-day.* What are its striking features? 1. That attendance should be made compulsory. 2. It recognized that education to a great degree should be a preparation for life's struggle. Hence the boy is to receive instruction in that which would most naturally be of use to him; the girl in that which would best fit her for the duties of housewife, never for a moment forgetting the education of the mind.

* At the annual meeting of the State Board of Education of New Jersey, held at Trenton, July 12, 1887, the following resolution was passed:

*Resolved*, That the State Superintendent, in the interval between the present meeting of the board and its meeting in November, make a full investigation of the subject of industrial education now applied to the educational system of other States, with a plan for its adaptation to the school system of this State, and as to the desirability of its adoption.

3. It in a sort recognized, what is now known as the "elective system," be it of mind or hand, for they are to work "at that Art, Mystery, or Trade, that he or she most delighteth in." 4. The necessity of moral and religious training in public schools is asserted. Matthew Arnold has recently reiterated the necessity of this, and no doubt greatly astonished many of his readers, by asserting that he finds to-day, in the public schools of Germany, a recognition of the fitness and propriety of religious instruction and an enforcement of the same, which can not be found either in England or the United States. 5. A fostering policy by the State was urged. How? In the very way that the great public-school system of our land has been established. 6. No distinction was made between the rich and the poor, the Indian's child and the Quaker's child. With a charity that marked everything done by a Quaker, this education was to be the priceless possession of all; with the foresight which was equally characteristic of the Quaker, he prophesied that these schools would be in a measure self-supporting. In the light of to-day was this a false presumption?

Lastly, how significant is the quotation from Yarenton, who is styled by Dove, the "Father of English Political Economy"!—significant, in that it reveals to us the food upon which our colonial statesmen fed; also, because of the index-finger pointing to Germany, from which so many modern educational ideas have sprung.

Whether Budd was the first to suggest this system of co-education of mind and hand in America, we do not know. He certainly must have been among the first. Remembering that he was a colonial statesman of West Jersey growth, this fact assumes added interest, when it is recalled to mind that in all probability the first public schools in this country to establish an industrial department were those of Montclair, New Jersey, and they not until September, 1882, nearly two hundred years after Budd's treatise appeared.

## SOCIAL SUSTENANCE.

By HENRY J. PHILPOTT.

### III.—SPECIALIZATION.

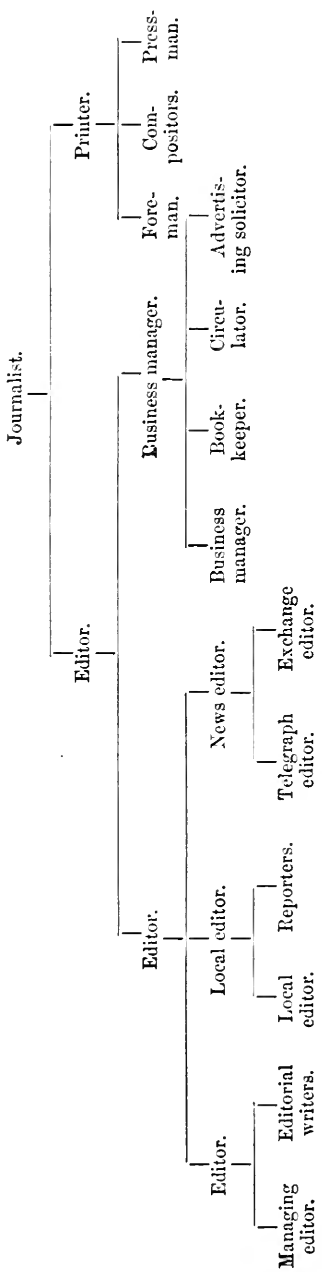
A GREAT scientific truth is expressed in the statement frequently heard that all kinds of work tend to run into specialties. Specialization is the order of the day. The term specialty is most frequently used in speaking of those sections into which the practice of medicine has been divided; but, in reality, we are all specialists. There is no more striking difference than this between our industry and that of a tribe of savages, or of a swarm of bees. The bees in a swarm are all engaged in the same few and simple operations. One bee does not exclusively make wax and another honey. Perhaps they would be no better off if they did ; but, for human beings, it is never doubted that specialization is a very profitable thing.

It manifests itself in two ways : 1. By the division and subdivision of existing specialties. 2. By the creation of new ones. The first is called division of labor, the second diversification of industry. It will be interesting to consider these in their order.

The practice of medicine offers us, in some respects, a good object-lesson. We talk most about specialties in medicine, for the very reason that it was one of the last occupations to be sub-specialized. Even now we have in the country, and especially in new countries, the general practitioner who attends to all the ills that flesh is heir to. He pulls teeth, amputates limbs, "doctors" the eyes and ears, and does, or tries to do, everything that all the medical specialists of a great city do. And yet his profession was itself, until within a few generations, an undivided and apparently indivisible specialty. The sub-specialties into which it has been divided may, in future, be still further divided and subdivided.

It would be interesting, if it were possible, to take some one great industry or profession, and trace out the pedigree of the specialties into which it has been divided. For an experiment in that direction, we might take the newspaper. It is now a very minutely subdivided specialty. Not only each political party, each religious denomination, each open and secret organization, but each line of business of any considerable importance, has its daily, weekly, or monthly journals devoted to its interests. And the number and variety of specialty journals are daily increasing. A list of their names would suffice for a chapter on industrial specialization. With the dates of their founding it would be a chart of the growth of the process. We should see here a process which, by reminding us of the division of the fertilized fowl's egg into feathers, bones, muscle, nerves, blood, skin, fat, etc., connects the science of political economy with all the other biological sciences.

But not only is journalism as a whole thus specialized ; the process is going on within each newspaper-office. The work is more and more divided, as the journal grows in circulation, size, and variety of contents. I shall attempt a diagram, on the plan of a royal pedigree, and it will be all the more instructive if it is not carried out to its actual limits, as exemplified in a metropolitan newspaper. Start with the original "journalist," who may yet be found in some Western county capitals, writing all his local items and general editorials, setting all his type, doing his own press-work, mailing or carrying his papers, soliciting subscriptions and advertisements, keeping and collecting his accounts—in fact, publishing the leading county paper, and "no thanks to anybody." He is the life-size presentment of "independence." He is still a specialist, but we know by the experience of others, even if we could not see at a glance, that his specialty is capable of indefinite sub-specialization. Starting from him as the original "journalist," we find his work divided in a neighboring city office in a manner which may be diagrammed thus :




And this is only the beginning. If we stepped into a metropolitan newspaper establishment, we should find the work still much further divided and subdivided. A whole article would be required to describe it briefly. And the same would be true of many other industries once considered such narrow specialties that, with some reason, they were believed to have a narrowing effect on the minds of those who pursued them.

The advantages thus gained have been dwelt upon by all economists since Adam Smith. They correspond quite closely to those secured by the specializations which Nature produces all around us in the different organs and tissues of plants and animals. A good deal of tedious hair-splitting would be required to define all of them, but they may be roughly divided as follows :

I. Those that appear immediately, as the ability to form combinations of effort not otherwise possible, or not without greater waste of time or greater expense for tools. The different parts in a play must be taken by different persons. This is made necessary by the very nature of the work. In other cases the same person might attend to many different tasks, but he would lose time in passing from one to another ; and he might require a greater variety of tools.

II. Those that come a little later, like the acquired skill of the individual specialist, and perish with him. Stradivarius devoted his energies to the specialty of making violins. By doing so he gave us the best violins ever made. The fact that they have never since been equaled shows that his slowly-acquired skill died with him.

III. But the man who pursues a specialty to success often learns rules of his art which he can impart to others, or even can not help imparting, since, like the peculiarities of the general form of a violin, they remain embodied and visible in the product of his art. He invents new machines or processes which survive him and are permanently added to the world's industrial power. This advantage of specialization is the last to be realized, and is probably the greatest.

Under which head shall we place the utilization of pre-existing special aptitudes? Under the first, on the ground that part of the advantage gained from them is immediate, under the second because they are susceptible of development by exercise, or under the third on the theory that they are due to heredity? They may be a part of the legacy of past specialization. Presumably this is true in general, and particularly in the most prominent of all specializations—that which separates man's work from woman's.

This brings us to an important practical subject which we may as well pause to consider. We all want a solution of the vexed problem of woman's industrial status. She wants it vitally and primarily, and is clamoring for it. She wants to know how best to make her living. In the great scheme of mutual helpfulness which constitutes the subject-matter of economic science, she wants her best possible place, as we all want ours. And we, in turn, aside from our sympathy for her, are interested in having such industrial capacities as she possesses, and is in a position to exercise, made the most of. I have stated as a general and vital economic truth that "the better living others make the more they help us to make ours." And yet half the population belongs to a sex which feels that it is denied, either by prejudice or some other cause, or both, the privilege of making the best living of which it is capable. If this be true, the first step toward reform is to find out why it is true. If we incidentally discover, in taking this first step, that reform is difficult or even impossible, none the less must we take it; for it will save us the waste of toilsome, futile steps in wrong directions.

A painstaking inquiry into the relations subsisting between specialization, heredity and special aptitudes can not fail to furnish us a clew to some part of the trouble. We often speak of the various differences, mental and otherwise, between man and woman. Among them all there is none more striking than this, that man's work has been highly specialized, while woman's has not. True, several specialties have been evolved out of her original specialty—as weaving, spinning, baking, etc. But these new specialties have mostly been given to men, not women. To all intents and purposes woman has now, as always, one specialty—housekeeping.

Hence the intense heredity of it. It is bred in the bone. The carpenter's son may fail to develop a special aptitude for working in wood; but the son of a long line of carpenters, whose male ancestors on his mother's side were also carpenters, would be sure to. This case never occurs. Masculine specialties are numerous. Male ancestors are also numerous. Their specialties are not one, but many. Now, if it happens that one of these ancestors had a specialty particularly adapted to transmission, which had become a part of his nature before his children were born, his posterity may have inherited his special aptitude regardless of the occupations of their immediate male parents. But, of course, it would all the time be diluted by its mixture with aptitudes inherited through other strains.

In the case of woman, every circumstance conspires to make the special aptitude intensely hereditary. It is acquired before the birth of children, hence is always transmitted. It has been transmitted, undiluted, from the female side, through countless generations. In a certain sense woman inherits masculine aptitudes from her male ancestors, But almost her only use of them is to transmit them to her sons.

In a few cases they are so strong that she yields to them and utilizes them ; and a part of her reward is that she is pointed to as an example that if women had the chance they would prove as capable as men. As a rule, girls inherit the industrial tendencies of their female rather than of their male ancestors, just as they do their voices, faces, and forms.

It is not worth while to quarrel with this fact, nor to quarrel about its original cause. It must be taken account of. From an unbroken line the woman inherits adaptation to a single specialty. From converging lines running back to a great variety of specialties the man inherits the capacity to turn his hand to many things, and measurably succeed in any one of quite a number. Woman has a "sphere," while man has spheres. How to bring about equality, or something more nearly approaching it, in this respect—the multiplicity of "spheres" —is the base of all there is in the famous "woman question." For, the moment woman has industrial potency, her way is clear to the realization of most of her other aspirations.

As compared with woman, man inherits versatility. But not all men are equal in this respect. Some inherit a larger assortment of capabilities than others, and with them the courage to abandon an adopted specialty the moment it becomes unprofitable or otherwise disagreeable, and take up another. Some whole communities have been so long tied to a single narrow industry that their inhabitants can hardly be trained to anything else. If that one industry for any reason ceases to be profitable, carried on in their way, they are comparatively helpless.

Grant that it is not good for a man to "have too many irons in the fire," or be "Jack of all trades and master of none" ; neither is it good for him to "carry all his eggs in one basket," or "have only one string to his bow." The man who is tolerably capable at several kinds of work is the better able to make his living while he is seeking the work at which he is most capable. Many men who teach school are free to say that they do it only as a stepping-stone to something else. A great many other occupations are occasionally or generally followed for the same purpose by young men. A very large part of the world's important work is "stepping-stone" work. It implies versatility of talent.

How shall woman acquire this versatility? Her industrial predisposition is a deeply-inherited instinct. How shall she break its fetters? Not very suddenly, we may rest assured. After long waiting she has slowly begun to take up, with slowly increasing success, those masculine tasks which the never-ceasing process of specialization has placed within her grasp. She works in those factories which have taken away from her general task of housekeeping some of the duties included in it in her grandmother's time. She watches the spindle and the loom of the factory, while the wheel and the loom of her grandmother gather and consecrate the dust of the garret. She carries her inherited instinct of baby-tending into the Kindergarten and the schoolroom. She even finds employment in those of the most mechanical masculine tasks which are not too muscular. It is gratifying, as well as scientifically instructive, that in all these lines her wages are gaining on man's.

Why not divide her main specialty of housekeeping? Men have made, out of much narrower and simpler ones, whole families of specialties. This it is that justifies our treating the woman question as a question of specialization, and taking it up so early. It is not a question of capital, banking, commerce, money, production, or distribution. It is a question of specialization, and, considered in respect of the number of specialists, one of the most important, since there are more women than men in the countries of greatest economic interest.

It is worthy our close attention for another reason. It is rich in revelations of general economic truth. Not all branches of any science are equally instructive. Some plants are botanically more interesting than others. Some animals are richer than others in zoölogical phenomena, and in explanations of phenomena. Woman's work, besides being everywhere present, so that we can all study it, is a peculiarly rich field of economic investigation.

It is not by any means a narrow specialty. It is intensely inbred, but of itself it is too broad rather than too narrow. Compare the variety of daily operations of man and woman. She must be constantly turning from one thing to another. She must dust, sweep, make the beds, watch the pot, spread the table, wash the dishes, attend the baby, sew, darn, and do so many petty things that almost any shallowness or distraction of mind on her part would be excusable.

Her husband, on the other hand, is doing one thing all day. He is laying bricks, carrying a hod, heaving coal, hammering iron, watching a loom, or doing some other single and simple thing all day. If, as some economists have feared, the minute division of labor has a narrowing and dwarfing effect on the laborer's mind, then we might expect semi-specialized woman to be the mental superior of man, unless otherwise dwarfed. For, although the metes and bounds of her sphere are more rigid than his are, within those bounds each woman must as a rule cover the whole field, while he marks out for himself a small and constantly decreasing stint, leaving the rest to others. Much of her former work, to be sure, he has taken from her; and the moment he got it he began to divide it into specialties. But enough still remains for nobody knows how many specialties. What keeps these possible specialties fast bound in one?

The family implies a home, the home a home-keeper. The family system, plus monogamy, implies one woman to one home, and no more. The appearance of two women at work in one home implies that one of them has not yet been fitted into her normal place in the monogamic family system, or has dropped out of it. She is filling a gap in her own life by a service aimed to ease and amplify the life of another. In this way the home of the well-to-do may contain several women, and in such cases they generally do divide and specialize the work. So do the women who are filling interstices in their lives by working in hotels and boarding-houses.

But taking the average woman, even in the most civilized communities, whatever of her hardest-worked female ancestor's household duties are still necessary to be done, and can not be done away from home, she must do herself alone. She must also do whatever new kinds of work the diversifying tastes of herself and family have called into being. Has she any escape consistent with the maintenance of the family system?

Are we driven to this dilemma, that either the institution of the family, which has done so much to ennoble the race, must go, or else woman's work must for all time be prescribed, like that of the slave, while man's is elective? Must the already excessive heredity of her occupation and aptitudes be still further bred in and in? If so, what manner of person will she finally be?

I confess myself unable to answer these questions to my own satisfaction. Before attempting it let me call attention to the light they throw on the nature of the science of political economy. It has been called a mental science. It has been called a moral science. It has been treated as a deductive science. It has even been treated as a matter of mathematics. Yet here, at the very outset, we find half the objects of its solicitude bound fast in the embrace of biological evolution. Their economic destiny is sealed before they are born. It is a biological fact, and as such we must study it. It is a fact not wholly psychological, nor wholly ethical, nor sociological, but physiological as well. It comes as near as anything to being omni-biological.

It will serve us no good purpose to deceive ourselves in such matters. Fine-spun optimism does not right wrongs. No tyranny was ever abolished by those who persuaded themselves that it did not exist. Delusions, like the belief in Santa Claus, may do a certain good by charming us in childhood or outside of business hours. But when we get to business, the thing we want to believe and must believe or fail, is the exact truth, no matter how unpalatable. So in regard to the status of woman we shall get no further by thinking it is either worse or better than it is, or more or less susceptible of conscious improvement. The doses of a dishonest quack are no more dangerous than those of a self-deceived ignoramus. We have all fallen into a habit of polite flattery of the nobility of woman's work. This is a convenient little bit of hypocrisy. We are very careful not to be too polite to the man or woman who does woman's work for pay. We may socially recognize the man or woman who does man's work for a stipulated salary, but not the one who so does woman's work. Woman herself, with all her kindness of heart, is just as clear of it as any of us. She always keeps the brand of social as well as industrial inferiority plainly imprinted on her inherited specialty.

Woman grew into her present economic position, and very likely she must grow out of it, if she gets out. There is no peculiar sanctity about the process of growth as compared with other economic processes. But it does need peculiar treatment in order to reach the results we aim at. We should see this quite plainly if we were called on within the same hour to advise in the case of a man with a broken leg, and a tobacco-sign which had suffered the same mishap. In most of our economic troubles there is an element of growth and an element of artificiality. With these two elements we must deal differently. And it will always help us to know in each case as it comes up, whether, and to what extent, growth predominates over artificiality or artificiality over growth. It can not hurt us to remember that an institution which was wholly artificial some hundreds or thousands of years ago, may now have reached a stage where growth enormously predominates over artificiality. In childhood, I amused myself by twisting together the two stems of a cherry-tree. The process was wholly artificial. But when the tree and I had reached maturity, its trunk was still neatly doubled and twisted, like a thread of yarn. I have often untwisted threads of yarn, but I was never foolish enough to try to untwist that tree after it had reached its bearing age. What was once wholly artificial had become almost wholly a matter of growth.

I could not even do anything to help it grow untwisted. It may be that woman and her specialty are as firmly entwined together as were the two stems of my cherry-tree, and can not be separated without injury to vitality, growth, and fruitage. They may even have to grow more and more intimately interlocked, conforming more and more to each other. If this is inevitable, we ought to know it; if desirable, help it on; if avoidable and undesirable, do what we can to prevent it.

It seems to me both desirable and possible that woman should diversify her aptitudes. The process will be slow, if possible at all, but it will soon begin to bear good fruit. In those cases where she must depend on salaried work for a living, it will enlarge her life by enlarging her pay. Her independence will make her more choice in the selection of a husband, which will be a blessing not only to herself, but to her offspring. I insist on the importance of the blessing to herself, and on her right to it. If one were disposed to find fault with the order of Nature, the worst thing to be said is that there seems altogether too much vicarious sacrifice in it. A majority of the lives brought into this world are offered up on the altar of that sacrifice. The sacrificial destruction of vegetable life need give us no pain. But the animal offerings, especially the human offerings, suffer torture in the ordeal, and enlist our sympathy. The economic development of the human race has cost untold sacrificial agony, mitigated by little or no reward to those who suffer it. We can not wholly prevent this. Our best efforts to reduce it often increase it. But latterly success has come often enough to stimulate more determined trial.

First of all, then, we desire that woman, for her own sake, should secure a more commanding position in the economic world. We can have no sympathy with the wide-spread, unmanly fear that she may become a wage-reducing competitor in the masculine specialties. Neither can we sympathize with the fear that her devotion to them will make her less enjoyable as a woman. Let it make her less a woman if it makes her happier. Let it, if necessary, make her less enjoyable to man. Is it of no concern that she should be enjoyable to herself? "I am a Jew," said Shylock. "Hath not a Jew eyes? Hath not a Jew hands, organs, senses, affections, passions?" And if a Jew, why not a woman?

But even if we had a right to ask it, what right do the facts give us to believe that, in order to be attractive to man, woman must spend all her time and energies consciously trying to be so? Let those who coolly assume this to be the case, tell us how they know that man, who has little or no time for such cares, is less attractive to woman than she to him. The grimy coal-miner, without even so much as a change of clothes, manages in some way to hold with a reasonably firm grip the affections of at least one woman. As for the "oak-and-vine" idea that one half the race can be attracted only by strength, and the other half only by weakness, that will do very well for poetry and flattery, but, if it is to do for science, it must be mercilessly tested.

So far as the test has been made, the idea may fairly be said to be disproved. In fact, the result is so encouraging to the parties concerned, that the consequently growing tendency toward the enlargement of woman's sphere may well give us hope, and stimulate us to help it on. This may be done by future inventions of machinery, or by the specialization of man's work to a point where much of it can be done by women. The dream of European economists, that through the conveyance of power by electricity the factory system is to give way to home-industry, may be realized, and woman's opportunities for sharing in a great variety of masculine tasks enormously increased. The public schools may some time be devoted more to sense and less to nonsense. Even though she must follow two or three hundred years behind man in her progress toward simplicity of dress, some of us may live to see her devoting a portion of the time now lost in that way to the cultivation, as an amateur if not otherwise, of some specialty hitherto monopolized by man. What she pursues as an amateur, her daughter, inheriting the aptitude, may find it convenient to follow for a livelihood.

Meantime, the calmness of our judgment will not be warped, though we indulge in sad contemplation of the fate yet in store for the millions of women who must be sacrificed to the good of the race, whose lives must be narrowed, whose natures dwarfed, whose care-worn minds cushed to insanity or suicide by the slowly-relaxing grip of an enslaving biological heritage. We may partially console ourselves by saying, as we did in the case of the negro, that she is born and bred to it, and can not realize how much better freedom is than enchainment. True as this may be in general, most of us do hear some complaint from the enchained. We like to hear it, because we despise the human being who has no aspiration to rise to higher things. The disagreeable feature of it is, that in the deplorable lack of economic training which woman shares with almost every man, she, like him, is disposed to attribute her troubles to the conscious intrigue or innate meanness of some class of human beings. It may be worth while to hint to her that, however irresponsible she may be, man is not responsible for her adoption of a style of dress which she would find very much in her way if she undertook to engage in some of the labors that he is free to follow. As to the willingness of her enchainment, that is a partial relief to her, but it is an obstacle to those who would break the chains. It is always harder to free a willing slave. But, when he has tasted liberty, he is very apt to like it. His callousness does not excuse the inactivity of those who have power to free him, whether or not they are responsible for his bondage. Woman's bondage is not to a person, nor to a class, so much as it is to a race—to an apparently necessary, but let us hope transitory, condition of the highest development of that race.

Turning with a sigh of relief to the economics of the sex which has hitherto monopolized the attention of the science, we find specialization hindered here, too, by circumstances over which nobody has control, or even very much influence. A large class of men, a full half of them in many countries, are in a case approaching that of woman.

The farmer's work, like woman's, may be thought of as consisting of a variety of operations which may in thought be separated. But in practice they are bound together by his isolation, by the meteorological conditions which separate seed-time and harvest, and make them both so short that the rest of the year must be filled up with other duties or wholly lost; and by other circumstances too numerous to mention. So he, like the woman, must go pottering around at odd jobs, never acquiring in any one kind of work that time-saving, nerve-saving, attention-saving proficiency which is rated by all economists, since Adam Smith, as one of the three greatest advantages of specialization. In a general way, to be sure, the farmer may have a specialty. It may be wheat, it may be corn, it may be cotton, it may be hogs, cattle, wool, horses, or what not. Whatever specialty he has, he usually gets from the nature of his soil, his distance from the market, or some inherited skill or inclination. But it is not usually an exclusive specialty. It does not furnish the whole of his employment, but only the most important part of it. In fact, it is regarded as rather a misfortune than a blessing that his soil or other environs should bind him down to any one crop. Thus, the exclusive cultivation of cotton is considered an unfortunate thing for the farmers of some of our Southern States. The loan companies, whose existence and profits depend on their making a deep and candid study of this question of agricultural specialization, are always glad to advertise to their loaning customers that their borrowing customers live in what they call an "all-crop" region. Seasons are uncertain: in the "one-crop" region the ill-wind blows nobody good; in the "all-crop" region it blows everybody some good, and the people who have money to invest in farm-mortgages think this is not wholly offset by the correlative fact that in such regions the good wind is pretty apt to blow everybody some ill.

We have now discussed the obstacles to specialization which lie in the way of about three fourths, numerically, of the population of the civilized world—one half being women, and half the rest farmers. We may now pass to those industries and professions aside from farming which must be carried on in the country, or in villages, as well as in large towns and cities. We find them less highly specialized in the country than in the city. The physician and the journalist, spoken of in the beginning of this article, illustrate the difference. It is most perfectly pictured to the eye when we walk into a country store, with its groceries, dry-goods, ready-made clothing, boots and shoes, hats, books and stationery, hardware, tinware, queen'sware, etc., and then, after a short ride on the train, go the rounds of the city shops, where all these things are separately handled.

It needs no profound scientist to tell us why. We see at a glance that density of population conduces to specialization. This is one of the ways in which it relieves its own evil consequences. World-crowding increases the necessity of our making our mutual help more effective, but it also opens the way, so far as specialization can help us on toward that end.

But it can do so only when it crowds the world with people who have the means and the inclination to purchase the services or the wares of the specialist. A given specialty can be earlier divided into sub-specialties in a rich than in a poor community of the same numerical population. Hence, the circumstance which promotes sustenance is likely to promote specialization. And since specialization promotes sustenance, it promotes itself. It is a case of "to him that hath shall be given." It is a case where two and two make more than four.

It follows, in turn, that what promotes specialization is likely to promote social sustenance. We have spoken of density of population. Let us analyze this expression. What do we mean by saying that population is dense? The answer is extremely obvious, but for the sake of the argument let us treat it as if it needed to be given. We mean that our human beings are close together. World-crowding is the only way to get them close together in person while occupying all the soil and mines.

Nevertheless, there is another way to accomplish the same practical object. If we can not bring them together in person, we can bring their products together. We can remove the obstacles to their communication with one another. The railroad, the steamship, the telegraph, the organization of carriage and commerce, have all helped to bring people together just as effectually, in an economic sense, as world-crowding does. Facile communication has ceased to depend wholly on density of population; facile communication means facile specialization, and it also means more beneficent specialization.

World-crowding was Nature's first crude and cruel method of bringing her highest creatures together, and specializing and civilizing them. Once acquired, the habit of specialization has been facilitated and its field extended by the more kindly method of commerce. The cruel and the kindly method have co-worked to stimulate industry. Whether the cruel process will go on when it is no longer needed, and partially rob us of the fruits of the kindlier process, is a question which we may leave to the prophets and to the future. In any case, what we of the nineteenth century are permitted to witness is probably only the infancy of specialization.

Meantime, let us turn to its other form—the creation of new specialties. Much of what we have already said applies here with equal force. Still, it may be worth our while to reflect that, besides dividing up the old work, we may, by searching, find out new work. Is it likely that all the ways of catering to the wants of society have been found and utilized? There is room here for the inventive faculty. A few generations ago the now highly-specialized profession of journalism did not exist at all, even in its simplest form. It has been but a few years since the specialties of making and attending to telephones were created out of nothing. To say that many other ways might be found to serve our fellow-beings and get pay for it, would be to venture into the realm of prophecy. But, if the past is any sign of the future, it is not wholly unwarranted prophecy.

We should say that in this direction there is probably work for every one of those unemployed laborers of whom we have lately heard so much. If they, or some capitalist for them, would forsake the old ruts of specialization, and, seeking some unsatisfied want of humanity, set about to satisfy it ; or if, finding no such want realized, they would set about to arouse and cultivate it, they might multiply their own opportunities, increase their pay, and by relieving the labor market in the old, overcrowded specialties, increase also the pay of their fellow-workmen remaining in those old specialties.

It is often said that there is no such thing as general over-production. I am not so sure of it. I am not sure that all existing occupations may not be overcrowded, and that what is needed may not sometimes be the creation of new ones. The creation of these new ones may be the very thing that will restore equilibrium to the old ones.

A certain amount of ingenuity is, in fact, every year expended in this direction. But might not more be profitably expended? There is a limit to the fertility of the soil, and to the stores of mineral wealth ; but what limit is there to the diversification of human wants? We know by the experience of all history that these wants arise and multiply naturally. We know that they may be artificially tempted into being.

Some of these unborn or unsatisfied wants might furnish profitable employments for which women would be especially fitted, and in which they could command large pay. I have no doubt the field is rich. So were the deposits of coal, iron, petroleum, and natural gas, which humanity needed so long before it had sense enough to want them or to find them. So were chemistry and mechanics as rich fields, before they were cultivated, as now.

We have to look upon humanity as a race half blindly, but with slowly opening eyes, groping after the opportunities which lie all around it. These opportunities are of two kinds. They consist not only in Nature's undiscovered resources for making us happy, but in our own ever-multiplying ways of being made happy. We have done with the old quarrel as to what is and what is not "productive" labor. We are familiar with the fine reasoning by which it is proved that the family doctor is a productive laborer because he increases our own working days and working capacity. This reasoning was needed to make him a place in the old narrow field of political economy, which included only the manipulation and valuation of material wealth.

In our wider economic field we find a place for every task by which our fellow-beings make us happy—by which they ease or amplify our lives. There is a place in it for the art, the music, the lecture, the drama, the professional ball-game, whose enterprising producers have taught us to love them for their own sake, and not because they make us stronger to dig, plow, buy, and sell. We do not ask whether these things increase the harvest or fill the net with fishes. They amplify our lives, and that is enough for us. We are willing to pay for the amplification, and that is enough for the specialists who render the service.

We recognize the resources that lie in human nature, as well as those that lie in the earth. Glancing at these, we see that humanity is as blind to the opportunities offered by its own expansible and multiplicable wants and satisfactions as to those offered by Nature's unexhausted capacity to supply old wants within old lines.

We can never safely predict just how much or little, nor exactly what, can be found by searching. We might be disappointed in our search for valuable and profitable new specialties. But if a great many tried it once, we might with good reason expect more benefit than has accrued from the associations of labor and capital that are seeking to control the old ones. For while the inventor of the specialty profits by his profession or business, the customers in whom he has excited a new want are thereby stimulated to greater efforts or greater efficiencies in their own old lines, since they must have means to gratify the new want. In this way the novelties that commerce offers to those it reaches tempts contented poverty and indolence into industry and civilization. It creates in the uncivilized the wants and thereby the efforts of the civilized, and hence the German philosopher was right who said that commerce is the great civilizer.

In conclusion, among the general principles of specialization we have discovered the following:

1. That it may arise either by division of old specialties or the creation of new ones.

2. That three-fourths of the population, women and farmers, are denied its highest development.

3. That heredity in specialization may be excessive.

4. That multiplication of human wants, as truly as multiplication of drafts on Mother Earth, conduces to specialization.

5. So do density of population and facility of communication.

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President Francis A. Walker urges for industrial education in the public schools equal consideration with science and other branches, because it directs and strengthens the executive faculty, and gives scope to the creative or constructive passion; arouses interest in a larger proportion of pupils; forestalls snobbishness and dislike and contempt for manual labor; contributes to a much-needed improvement in the industrial quality of citizens; helps to quicken the sense of social decency which is manifested in keeping houses and yards neat and trim; supplies, from the girls' side, good cooks, housekeepers, and sewers; and, by the exhibition of practical results for good, makes the schools popular, and appeals to the whole community to be interested in them and maintain them.

# ETHNOLOGICAL SKETCHES IN ANNAM AND TONQUIN.

THE curious philosophical views of life which appear to be common to the races of the Chinese stock, and the elaborate ceremonials by which they are symbolized and emphasized, give a rare interest to all that relates to the manners and customs of those peoples, whatever may be their particular nationality. Nowhere are these features more marked, or do they savor more of another world than ours, than in Annam. We are indebted to certain French writers, whom military and political events have given rare opportunities to observe, for some fresh and original accounts of the inhabitants of this country, and of their characteristic beliefs and usages. M. Henry M. d'Estrey has given, in the "Revue Scientifique," descriptions of the principal ceremonies prescribed in the rites to commemorate the most important events in life, which are six in number, viz.: 1. *Gèa Kê*, or the imposition of a pin in the hair-dressing of a maiden on her reaching puberty; 2. *Gèa Quan*, or the imposition of the virile bonnet on the head of a young man when he reaches adult age; 3. *Quan*, or the feast in celebration of obtaining a first employment; 4. *Hôn*, or the marriage ceremonies; 5. *Taŭg*, or funeral ceremonies; 6. *Té*, or the ceremony of ancestral worship.

The first two ceremonies are celebrated by the relatives, in the family. When a maiden has reached the age of nubility, or fifteen years, the father and mother adorn the two altars erected to the ancestors of their respective families, invite the near relatives, and select, as president of the ceremony, an aged lady, of high repute for virtue and good sense. While the lights are burning among perfumes, two masters of ceremonies, one at each end of the altar, call off the order fixed by the rites. The father and mother then come up to the altars, and say in a low tone, "It is our duty to inform our ancestors that our daughter is, according to the rites, marriageable from this day, and that the age of fifteen years, which she has reached, gives her the right to wear the pin." They then prostrate themselves four times, and the other relatives follow, imitating them. Next, the maiden is brought up to the altar, and the lady who presides over the ceremony, or sometimes the mother herself, takes the pin from off the altar and places it in the hair of the maiden, when, after having saluted the altars four times, she takes her back into the house. At any time after this the maiden may marry. The ceremony is followed by a festival, which is attended by the participants.

The ceremony of the imposition of the virile bonnet upon the young man who has reached the age of twenty years is performed with similar observances; but the father or an old man takes the place of the mother or aged lady in making the investiture.

The third ceremony takes place when a son of the family has passed the examination for the public service; for competitive examinations rule in the Annamite Government positions. The parents announce the happy event to the ancestors at their altar, and give a banquet, to which the local notables, the friends and comrades of the young man, and the acquaintances of the family, are invited.

Marriage is celebrated in different styles, according to the fortunes and conditions of the families. Mandarins, *literati*, and nobles, go through six distinct ceremonies, which, occupying months, and perhaps years, it would take a volume to describe in detail. The families frequently pledge their children to one another at a very early age. This is especially the case when parents advanced in years have young children; they then engage the children, not to force their inclination in advance, but to assure to them an honorable alliance while they are still able to make provision for them.

Marriage settlements and dowries are not recognized, on account of the difficulties that might arise in case the marriage is dissolved. According to Annamite custom, the woman should not bear the charges of marriage, because she takes the name of her husband and associates herself with him in order to perpetuate his family, not for the sake of her own. It is just for the husband, in his own personal interest, to furnish all that she and her children may need; yet, according to another custom frequently followed, the suitor whose character is not well known should make several visits to the family of his affianced, so as to submit himself to a kind of testing often very severe, which shall permit his value and the amount of his knowledge to be rated. This stage of the negotiations sometimes lasts for several years.

Marriage is usually contracted by inclination, without money considerations entering into the matter. The family is regarded as a moral union, and not as a business association. Hence it is common to see a wealthy family allied with a poor one. It is considered that, when a man marries a girl without fortune, but wisely brought up, she will be easily touched by the care he will take of her, and be obedient to his authority. Then, it is not right to exact a dowry from a girl whose education has already imposed on her parents large sacrifices of time and money, and who has, moreover, abandoned her family name to take that of a stranger, so there is no dowry. The parents give their daughter what they please, without the young man being allowed to claim or stipulate for anything. Sometimes they require him to make considerable presents, which will be the sole property of the wife. It must not be supposed that the condition of wives is the same in Annam as in China. The six ceremonies of marriage are, it is true, nearly the same in both countries; but while the Chinese wife has to keep to her apartments, the Annamite wife is treated as the equal of her husband.

This equality is revealed both in the division of authority and in the matter of honors and distinctions. When a man, in consideration of his having rendered great services to the Government, or done a good to the people, obtains a decoration, like insignia are conferred upon his wife. The legislator appears to have thought that a husband would not have had leisure to consecrate himself so closely to the defense of the public interests, if his wife had not been faithful and devoted; if by attending to the orderly direction of his household, she had not relieved him from the care of his personal interests, and left him in full liberty of mind. Women can also obtain official rewards, when, having become widows, they keep faithfully the name of their husbands, and distinguish themselves by the manner in which they bring up their children and administer the estate which the father has left them. The emperor then decrees them a framed diploma, which they hang in their house, and on which, by the side of their name, figures the mention of their virtues.

The duties of the married woman consist in the cares required for the well-being of her husband and children, and the becoming reception of relatives and friends. She has the preparation of the festivals for the ancestral anniversaries, taking precedence in this case of her husband's sisters, by virtue of the rights which her title of legitimate wife, member of the family right, gives her upon the administration of the domestic cult. The interior management of the house belongs to her exclusively. She has full control over the servants, and supervision of the expenditures and receipts. Although invested with such extended powers, the Annamite women have the additional merit of being submissive, patient, and little inclined to coquetry. They spend but little for dress, and the caprices of fashion are unknown to them. When they attend any ceremony or visit relatives or friends, they wear the dress and jewels which their husbands gave them as marriage presents. When jewels are bought in rich families, they are not intended to be worn by the purchasers, but to be reserved for the marriage presents of the children.

Balls are regarded by the Annamites as scandalous affairs. It is contrary to the rites for men and women to take one another's hands unless they are relatives or friends. According to the philosophers, the male element tends to seduction and the female element to levity; their contact in familiar interviews could therefore be only a temptation to innocence. It is for this reason that the affianced man is not allowed to make his court to the woman. Although the theatre is supposed by the Annamites to exhibit good manners in action, it is usually attended only by men and elderly people. Girls go occasionally, but always accompanied by a member of their family.

The education of the children begins even before they come into the world. The prospective mother is at once submitted to a kind of material and moral *régime* sanctioned by custom. Gross viands are removed from her table, and her slightest movements are regarded, that they may be regular and majestic. She is expected to listen to the reading of good authors, to music and moral chants, and to attend learned societies, in order that she may fortify her mind by amusements of an elevated character. And she endeavors, by such discipline, to assure to the child whom she is about to bring into the world, intelligence, sagacity, docility, and fitness for the duties imposed by social life. In confinement ladies are attended, not by the ordinary doctors, but by women especially devoted to the calling, who regard their profession as honorable and humanitary. The birth of a child is signalized, especially in the country, by setting up in front of the house a bamboo stick, in the tip of which is inserted a half-burned piece of wood. A glance at this stick is enough to tell the sex of the child. It is a boy if the burned end is turned toward the house ; a girl, if the black is turned in the other direction. The arrangement is symbolical, is of an origin that is lost in the darkness of the past, and signifies that the son will some day succeed his father in the government of the family, while the daughter will leave the paternal mansion to enter, by marriage, a strange one. It is customary to give the child a year on the day of its birth, and a second year on the first day of the succeeding calendar year. Thus a child born on the 30th of December, 1886, would have been counted as of two years on the 1st of January, 1887. This way of counting ages makes the first day of the year a day of general festivity, for it marks for every one, no matter what may have been his real birthday, one year more, and thus represents a common anniversary. A month after the birth the family gives a festival, to which the relatives and friends are invited. An elderly person, man or woman, according to the sex of the child, who must also be of good repute and well instructed, is chosen to give the child its particular name and transmit to it the first notions of things. In this ceremony, called *M'ach-Miêng*, which accompanies the festival, the person who presides passes a ruler several times before the mouth of the child, pronouncing some consecrated words ; then, with a freshly-plucked flower, he sprinkles pure water over its head and body : this symbol signifies that the child, when it has become master of its actions, will take just reason for its guide, and will guard itself against contaminations and vices. Another ceremony, of an entirely different character, takes place a little later. It is called *An-Thoi-Noi*, which means leaving the cradle. The parents bring the child before the altar of the ancestors and present their youthful descendant to them. They then place it among a collection of objects appertaining to various trades, and let it choose the one toward which its instincts draw it. Its choice, directed by the spontaneous aspiration of a virgin mind, will indicate the way which it is some day to follow. This ceremony, which is of ancient origin, is, however, nearly abandoned now. The child is given to the care of the nurse only when the mother is prevented by sickness or some other serious cause from nursing it herself.

If the child is a daughter she is intrusted, when she has become of suitable age, to the care of a discreet and virtuous woman, who attends to her education in the house, under the eye of the mother. The education and instruction of the daughters are considered of prime importance. It is the first condition of the prosperity of the family, who can not possess a more precious treasure than a competent woman, respected by all, orderly ruling her house, bringing her children up in virtue, and wisely directing a numerous personal establishment. The instruction of girls includes the rules of deportment and politeness, reading, writing, and arithmetic; music and literature; weaving and needle-work; the culinary art, and all the various matters which it is important to know in the management of the house. So, when we notice that the heads of the family are elegantly clothed, that the table is well served, and that order and good taste prevail in all the details of domestic life, we at once discern the presence and the judicious activity of a well-trained and accomplished daughter.

The boys are also brought up in the family; but they are taught in the public schools, where they attend during the day only. It is usually judged best to seek instructors for both sons and daughters outside of the family. The parents consider themselves disqualified for the exact discharge of the teacher's work by the strength of their affection, and too likely to err in the direction of over-indulgence, or in the opposite one of undue strictness.

A more circumstantial account of the celebration of the New-Year's festival, referred to above by M. d'Estrey, is given by another French writer, M. Gouin, in the "Bulletin de la Société de la Geographie." In honor of the anniversary, the Government offices and more important business establishments and enterprises are closed or suspended from the fifth day preceding to the fifth day afterward; but the poor need take a vacation of only twenty-four hours. All is silent and still in the town, except for the firing of shooting-crackers and the going about of the people dressed in their best and carrying presents, on their visits of ceremony. On the eve of the festival a green bamboo is planted in the court-yard by way of invitation to the ancestors and deceased relatives to come and partake of the repast which has been prepared for them. A flag-staff is set up at the front door, adorned with palm-leaves, feathers, etc., to which a lantern is hung at night. Within the house the disposition of the furniture has been entirely changed, and everything is given a holiday look. Bows and arrows are chalked on the ground at the entrance to keep bad spirits away, and sometimes the door is further obstructed by abattis of thorn-plants. A little square niche on one side of the wall without is reserved as an altar in honor of the genius of the quarter, on which offerings of burning torches, incense, flowers, meats, and gilded papers are made, with the firing of crackers by the bunch. The ancestors may be attending the feasts at any time. During the last three days of the ceremonies, their tombs are cleared of weeds and given the repairs which their condition may require. A long lacquered table is set in the principal room, and above it a large red tableau, on which are represented various personages, flanked by characters and sentences enumerating the qualities that distinguished them or those which they would have liked to have. On the table are placed a variety of offerings to the spirit of commerce, who is invoked to bring prosperity. The place of honor, which usually looks upon the door, and the most generous offerings, are given to the ancestral altars. The grand repast takes place at midnight on the 30th ; and as a result of what goes on then, the Annamites, usually sober, begin the year in a very drunken condition. In connection with this feast, a quantity of last year's water is compared by weight with the same quantity of the water of the new year. If the latter is the heavier, it is a bad sign, and inundations may be expected ; if lighter, the air of the new year will be pleasant, and the rivers will flow placidly. At the final repast, on the 4th or 5th of the new month, the departure of the ancestors, who are supposed to have been present at all the ceremonies, is celebrated with the burning of gold and silver papers. The houses are not opened after the festival for the resumption of business if the weather is bad ; for the sun must be the first to enter them, or something unpleasant might happen.

M. d'Estrey, continuing his account, observes that there are no public cemeteries in Annam. Every person seeks for a suitable place of his own in which to bury his relatives. Not rarely families keep the coffins of their relatives—very solid and tight structures of wood—in their houses even for a considerable time. Poor persons are sometimes buried in grounds given by the more wealthy for that purpose. Mourning is worn in white. Its duration is fixed according to the nearness of relationship ; for father and mother, three years ; for grandparents, brothers, and sisters, one year ; and so on. Persons who are in mourning must not appear at public spectacles or dress elaborately, or indulge in any gayety. After the mourning has terminated, a family festival is celebrated at each anniversary, when a repast is offered upon the ancestral altar. The formal visit to the tombs, the keeping of them up, and the duty of attending to the rites of ancestral worship, appertain to the heads of the family, the other relatives only following their orders in the matter. After reaching fifty or sixty years of age, parents who have children large enough to attend to affairs leave the general direction of their houses to them, and devote their attention to giving honors to their ancestors. The cost of ancestral worship in Annamite families is lighter than the cost of church services in France. The heads of families are themselves priests, and have only to say a brief ritual on the occasion of the anniversary of the death of each member of the kindred. Besides the special family altars to each ancestor, there exist temples consecrated to all the members which the same kindred has counted in the past. At a designated day, all the members of the family present themselves there to make their sacrifices. The ceremonies are directed by the nearest or most aged relative. The character of the offerings depends upon the tastes the ancestors are supposed to have had while living. No pictures or statues of the ancestors are erected to preserve their features; only the name is to be seen on the altar, inclosed in a little tabernacle and written in large letters upon a tablet. The image of the ancestor is in the Annamite's heart, and is not represented materially by painting or sculpture. It is not presumed that the souls of the ancestors are present at the repast which is prepared for them; but it is understood that, in offering sacrifices to them, gratitude is expressed for the time when the worshiper was the object of their constant solicitude, and faithful recognition is given of the days when he was held upon their knees, and the painful moment is recalled when they were forever separated from their children. Filial piety is the motive of all the acts of the Annamites' life. Their feeling was thus described to M. d'Estrey by an Annamite: "We have a desire to discharge the debt that we owe to our parents; to that tender mother who carried us in her womb, who brought us forth in pain, nourished us with her milk, and caressed us on her knees for years; to that watchful father who laboriously brought us up and constituted himself our first guide in the labyrinth of the world. It is a common remark that every service rendered ought to be recompensed. The benefaction by which it is given us to enjoy life, to know what is, to raise ourselves through the spectacle of the virtue of our parents, from the simple creature to the most high—what other can be compared to it? It is for this reason before every other one, to render ourselves worthy of our parents, to make their name as illustrious as possible, that we try to obtain a rank among men that shall do honor to our house, and in which we may some day serve the great interests of humanity. We hope that in this way the spirits of our parents may enjoy a peaceful happiness in contemplating us from the celestial world."

M. Mahé de la Bourdonnais has given an account, also in the "Revue Scientifique," of tribes of people inhabiting portions of Annam, who, although considered savages by the Annamites themselves, are still possessed of a civilization which is of the greatest interest.

Some of them pay tribute to the King of Siam, others to Annam, while all are more or less under the control of certain prefects. A chief, whom they regard as a father, acts as judge, punishes the guilty, and vigilantly guards the observation of the ancient rites and ceremonies. Much respect is shown to these patriarchs, and their people aid them in building, labor in their fields, and yield implicit obedience to them. The wives of the chiefs generally marry one of their own rank, but this is not compulsory. If they marry beneath them, they lose their claims to nobility, and are fined for not having retained their rank.

When, as frequently occurs, the chief does not live in the village, of which he is the head, his place is filled by one of the nobles, who, acting under the orders of the chief, attends the deliberations of the council, furnishes the requisite number of men for the husbandry service, and communicates the wishes of his master to the people.

The religion of all of these tribes is one of fear: a constant offering up of sacrifices to propitiate evil spirits. Famine, plague, sickness, and misfortune are supposed to have their origin with them. They preside over all things, and govern at will. The waters, the forests, each tree, each mountain, is inhabited by spirits; even the villages are supposed to be governed by them. Hence, they build huts at the entrances to their towns wherein these guardian spirits may dwell, and yearly sacrifices, consisting of various animals, are offered up to them, lest the harvest fail. Sacrifices are also made when one of their number is sick, in order to drive out the evil spirit, or at least to appease it. Their house-spirit is the only one for which they have any respect, as they imagine that their ancestors from time to time re-visit them, and a small table in one corner of the room is always reserved for them. At certain solemn occasions this table is saluted by them with the greatest respect. As a general rule, however, these people care very little for their gods, excepting in time of danger and misfortune.

The huts of the principal tribes are constructed of wood and built upon piles. The walls are of braided bamboo, made in such a manner that, even when the windows and doors are closed, there is little difficulty in reading and writing within, the poor braiding allowing the entrance of light. The roof is also made of bamboo covered with palm-leaves. Not a single nail or pin is used in the construction of these houses. When a new one has been completed, the head of the family makes grand preparations to properly celebrate the event, according to his means. Oxen are killed, wine is drunk, pipes smoked, and there is general rejoicing on the part of the family and its guests. Intoxication, however, is rarely met with on these occasions.

The interior of the hut corresponds in simplicity with its exterior, In order to gain admission it is necessary to first climb the ladder suspended from the door; before entering the feet are bathed in a long bamboo tube filled with water, as shoes are but little worn. As there is no outlet for the smoke arising from the fireplace, excepting through the roof and the crevices at the sides, the room is constantly filled with it. Three large stones serve as a tripod. Shelves containing rice, salt, and other articles of food are ranged about the room. Knives, hatchets, and the indispensable bamboo tube containing fresh water, are conveniently placed. On what may be considered the ground-floor, fowls, pigs, and other domestic animals make their home.

Rice is the principal food, and they obtain a very delicate flavor by steaming it through a bamboo tube. Smoking is indulged in to a considerable extent.

These people are, generally speaking, somewhat careless, apathetic, and without fear for the morrow. Hence, they live in a sort of hand-to-mouth fashion, confining themselves to the cultivation of the narrow strips of land at the foot of the mountains. The fields are very small, and water is frequently brought to them by means of canals. The men work the fields with a light plow, but often dispense even with that, and use a harrow, the teeth of which are made of bamboo. Ordinarily there are two harvests, excepting in certain districts, where the winters are too severe.

The men rise at daybreak at all seasons of the year, smoke their pipes, lounge about the house for a time, then work in the fields until about ten or eleven o'clock, when they return for breakfast. A short sleep is then indulged in. The afternoon is spent in roaming about the mountains, fishing, hunting, or gathering bamboo. The evening is passed at home. At about eight o'clock the only other meal of the day is partaken of. Their dress resembles that of the Annamites.

The women here, like those of most other wild tribes, are the real laborers. They pound and gather in the rice, bring fire-wood from the mountains, spin cotton, make cloth, prepare the meals, and, in a word, do almost all that is to be done. Each member of the family, however, works at his or her pleasure. The result of this freedom is a lasting friendship between the members of the same family, and frequently the children, even after marriage, will remain under their parents' roof; thus, three or four families are often found living together in perfect harmony. The women are usually very poorly dressed, and make a less agreeable impression than the men.

Great affection is shown toward their children, so much so that paternal authority is apt to suffer. When a child is born, a string is suspended near the mother and the infant to prevent the devil from carrying it away. Bits of rice are also put into the child's mouth with the words: "If thou art of the devil, let the devil slay thee; if thou art of Heaven, let Heaven protect thee."

Marriage does not take place until the men have reached the twenty-fifth year, as it is necessary to have a considerable sum of money for the bride's parents before the event can take place. The fathers and mothers manage the affair almost entirely themselves. Three visits are made between the parents of the contracting parties; on the fourth, the bridegroom accompanies his parents, carrying the money, a pot, a pig, and a jug of wine. He invites the parents of his future wife to feast; they furnish a pig and a jug of wine also, and the two families make their repast in common. A chicken and an egg are now prepared; each is cut into two equal parts, wishes for their future happiness are expressed, and the couple invited to eat.

They drink wine from the same jar, and are both seated upon one mat; congratulations are renewed and another feast spread, this time at the house of the groom's parents. This concludes the ceremonies.

Cases of sickness are generally treated by the application of roots, herbs, and leaves; each family possesses certain preparations, whose composition is kept secret. There are no physicians, and they apply their own remedies.

When any one of their number dies, friends and neighbors hasten to the mountains, hew down a tree, hollow it out, and, after having washed and dressed the body, put sugar-cane into its mouth, and invoked the shades of the dead, place it in this rude coffin, open the eyes so as to look heavenward, and then carefully seal it up. On the day of burial, sacrifices are indulged in, according to the means of the relatives of the deceased. The grave is usually made in a forest, and the hewing of trees therein is superstitiously avoided. A soothsayer, or priest, plants two reeds at the borders of a stream in such a manner that the parents of the dead can pass underneath; while doing this, he sprinkles water upon them which had been used to clean rice. After washing their clothes and cutting their hair, they enter the house, and, in order to show the depth of their sorrow, throw everything about the house into confusion. The priest arriving, he reproaches them, restores order, and sprinkles a kind of holy water in order to drive out the evil spirits.

The language of these tribes is a mixture of the Annamite and Chinese. It is chanted in a manner peculiar to the former, but differs somewhat in sound. Thirty-six letters comprise the alphabet, a peculiarity of which is that there is no letter corresponding to our *r*.

## CORK, ITS MANUFACTURE AND PROPERTIES.

By ARTHUR GOOD and WILLIAM ANDERSON.

A CONSIDERABLE number of trees, including the cherry, birch, elm, plane-tree, and maple, produce a corky substance in their bark, but in too thin layers to admit of economical use. In Brazil, the bark of a tree of the family of *Bignoniaceæ*, and the pith of *Pourretia tuberculata*, of the family of *Bromeliaceæ*, furnish a kind of cork, as does also the *Euphorbia balsaminifera* of the Canary Islands. But none of these substances is capable of any important use.

Two varieties of oak, the cork-oak (*Quercus suber*), which grows in the Mediterranean basin, and the Western oak (*Quercus occidentalis*) of Gascony, share the monopoly of the production of cork in thick-enough sheets to be utilized. But the natural cork which they furnish, and which is called male or virgin cork, has, whatever its thickness, but slight commercial value; and it is not employed industrially till it has been improved by cultivation. An article of cork, a bottle-cork, for example, is therefore doubly an industrial product: first, as a substance, the qualities of which have been brought out by perfected processes of cultivation and harvesting; and, secondly, as an article that has been manufactured, either by the hand of man or by a machine. It will hence be profitable to study the processes of cultivating and gathering the cork, and the various industrial applications to which the substance lends itself—subjects concerning which no well-composed account has yet been given.

The bark of the cork-oak is composed of two distinct concentric layers: an inner sheet, which is the active part of the bark, and corresponds with the liber of other trees; and a thicker, outer zone, composed of light, compressible, spongy substance, only slightly permeable to liquids, and constituting the cork proper. Wherever upon the body of the tree the inner sheet, or "mother" bark, is destroyed, no further formation of bark or wood takes place; and even a narrow decortication clear around the tree would cause it most certainly to perish. The other coat, or cork, is inert, and does not contribute to the active functions of vegetation; and this explains how it is possible to strip the cork-oak of its corky envelope without endangering the existence of the tree. The inner bark, moreover, if left untouched, will form yearly new layers of cork which may ultimately, when they have become thick enough, be removed in their turn, and furnish the cork of commerce, also called female cork.

According to the most excellent account of the process, given by M. Matthieu, in his "Flore forestière," the *demasclage*, or removal of the cork, is done in July or August, when the condition of the sap-movement permits an easy separation from the "mother." The work must be suspended when the winds of the sirocco are blowing, for they would destroy the vitality of the inner bark by drying it up immediately; and about two per cent of the trees are likely to be lost, if the operations are crudely performed, by exposure to the glare of the sun. The renewed young bark, if it is permitted to form itself in contact with the air, is also exposed to the attacks of insects and liable to become cracked. To obviate these disadvantages, M. Capgrand Mothes, a French sylviculturist, has devised a method of clothing the stripped oak-trees, by replacing and leaving upon them for a while the cork-bark which has been taken from them. Having been removed in the shape of two half-cylinders, it is easily tied back upon the trunk with wires, while the joinings are covered with strips of paper. The dress is taken off at the end of three months, when the cork which has been utilized to compose it will be found to have become better seasoned than it would have done by the usual method of stacking it. The new bark, under this protection, will have formed only a thin, superficial crust, and that free from cracks and the marks of insect-stings. This process, which furthermore protects the trees against hot winds and insolations, has the additional advantage of expediting by a year the time when the next crop of cork will be fit to gather in.

Before being put into the market, the bark has to be subjected to the operations of steeping, scraping, sorting, and packing. The object of the steeping, which is performed in large boilers of water, heated by means of chips of the bark, is to swell the cork and increase its elasticity, and it has the further effect of enabling curved pieces to be made straight. Scraping, for the removal of the woody parts, is done with iron scrapers, or with a machine in which the rotating chisels make nine hundred turns in a minute. It involves a loss of twenty-eight per cent of the crude bark, but is not so necessary when the formation of the young cork has been protected in the manner that we have described. In England, these two primary operations are replaced by a process of scorching and brushing the bark. The sorting is done with reference to five degrees of thickness, after which the bark is packed in bales containing about two hundred pounds each. At the market it undergoes another testing for quality, in which there is a wide range, and a corresponding diversity of prices. According to M. Lamey, in his book on "The Cork-Oak in Algeria," the bark should never be gathered till it is seven eighths of an inch thick, and that is preferred in commerce which is from one and an eighth to one and a quarter inch thick. To produce such thickness, from six to nine years of growth are needed.

The density of cork varies with its quality and age. Thin corks are usually heavier than those of the same volume that have grown more rapidly, and, in corks of the same class, the density increases with the age. M. Brisson gives 0·240 as an average maximum, and the ordinary density of a ten-years-old cork may be taken at 0·2. With extreme lightness are associated other valuable qualities: that of being a poor conductor of heat and sound; impermeability to liquids; imperfect combustibility, and non-liability to decay, by reason of which it is susceptible of very numerous applications in industry. The most important use of the substance is for bottle-corks. The bark which is intended to be used in this form is kept in a damp cellar. When taken to the shop, it is cut by the first workman into strips, the width of which corresponds with the length of the future cork. A second workman cuts these strips into squares suited in size to its diameter. The squares, strung, are plunged into boiling water to make them swell out. They are then stored in a cool place, and kept constantly moist by sprinkling, till they pass into the hands of the cork-maker. He applies them in succession, giving them a rotary motion, to the edge of a wide-bladed knife, drawing them at the same time slowly along its length, and by skillful manipulation transforms the square into a round cork. This is the method usually practiced in France. Workmen in other countries handle the knife in different manners. It is essential, to obtain a good and solid cork, to take care that its axis, as it is cut from the bark, be parallel with the axis of the tree on which the bark grew; but the broad, flat corks have to be cut perpendicular to the axis of the tree. Only the finest corks are now made by hand. A good workman can turn out, in the method described, about one thousand corks a day.

We give representations of three machines invented by Demuth, which are so simple in their operation that any one can make corks upon them at the first trial. The first machine cuts the cork into strips (Fig. 1); the second into squares—eight thousand a day with a

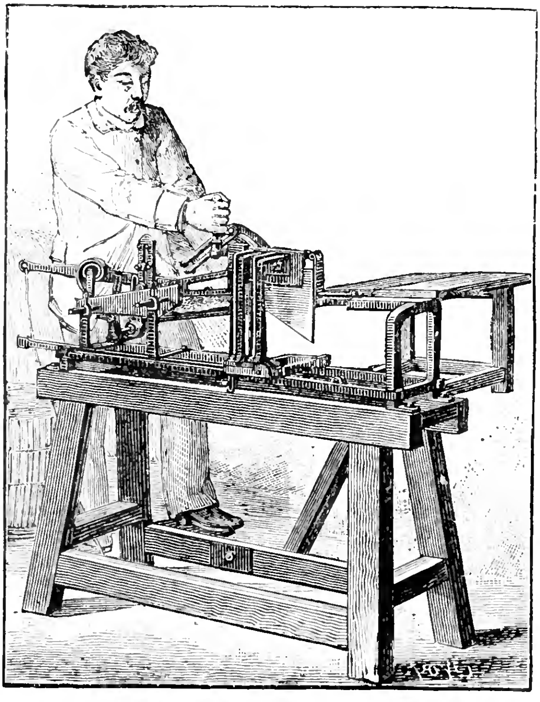

Fig. 1.—Machine for Cutting Cork-Strips.

woman or a child to work it (Fig. 2). This machine separates the squares automatically, according to their sizes, and by an ingenious arrangement the knives are made to sharpen themselves by passing over a whetstone-rubber at each forward and return motion. With the third machine, for shaping the corks, five thousand corks may be finished in a day (Fig. 3). It is so arranged that the square of cork, firmly fastened between two pointed jaws, turns with them in front of a knife-blade, which is managed with the hand after the fashion of a plane. This blade is so connected by a chain-gearing with the jaws holding the cork, that the movements of the two tools are in harmony with one another. The parts of this machine can be arranged to cut corks of any size, and of cylindrical or conical shape as may be desired. The conical corks are used when the corking is done by hand, the cylindrical ones when it is done by machinery. Other machines for punching corks into shape and for grinding them have been tried and discarded. M. Moreau, the inventor of the latter machine, combined with it the idea of cutting a portrait-face on the cork,

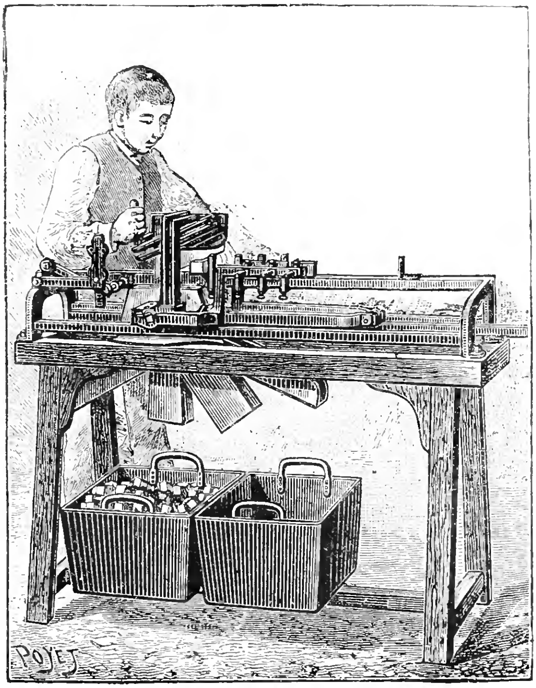


Fig. 2.—Cork-Square Cutting-Machine.

so that every house might send out the image of its chief on its wares; but the device has not advanced further than to the stage of a happy thought. Another machine has been invented in which the knife is a rotating disk, self-sharpening, and the cork also turns.

After having been shaped, the corks are washed in water containing oxalic acid or chloride of tin, or are sometimes treated with sulphuric acid. They thus acquire a characteristic salmon tint, and become velvety and soft to the touch. They are then sorted according to size, tested for quality, counted by hand or by the aid of special machines, and packed in sacks containing from fifteen to thirty thousand each.

The quality most sought in a good cork is impermeability to gases and liquids. The bark may be tested for this quality before making up, by means of an apparatus invented by M. Salleron, in which it is subjected to the pressure of a liquid which has already been compressed in a hydraulic machine. A cork of the first quality should stand a pressure of several atmospheres without absorbing any of the liquid. The waste in cork-making amounts to about sixty per cent; but the chips can all be put to profitable use in making chalk-powders, linoleum, and feltings.

A large number of other substitutes for stoppers of cork have been tried. Those which have given the most satisfaction, in particular cases, are made of ground-glass and India-rubber; but no other device has come into a real competition with cork.

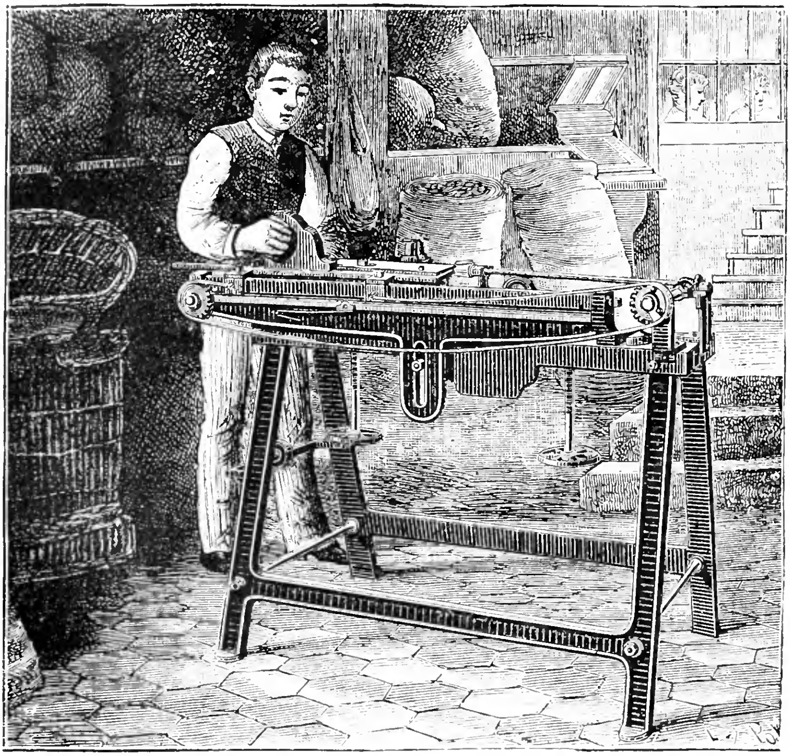

Fig. 3.—Machine for Trimming Corks.

Mr. William Anderson, describing some new applications of the mechanical properties of cork to the arts, insists, as the peculiar quality which distinguishes it from all other solid or liquid bodies, upon its power of altering its volume in a very marked degree in consequence of change of pressure. All liquids and solids are capable of cubical compression or extension, but to a very small extent; thus water is reduced in volume by only $\frac{1}{2000}$ part by the pressure of an atmosphere. Liquid carbonic acid yields to pressure much more than any other fluid, but still the rate is very small. Solid substances, with the exception of cork, offer equally obstinate resistance to change of bulk, even India-rubber, which most people would suppose capable of very considerable change of volume, being really very rigid. The latter substance can be compressed indefinitely in one direction while it is left free to move and expand in other directions. When tightly inclosed so that it can not yield, it can not be compressed by any force that can be brought to bear upon it. In the former case all the volume which is lost by the pressure in one direction is regained by the expansion in other directions, and the whole is not changed; in the latter case there is no room for the compensatory expansion; so when India-rubber is stretched, it gains in volume in one direction at the expense of an equivalent loss in other directions.

Metals, when subjected to pressures which exceed their elastic limits, so that they are permanently deformed, as in forging or wire-drawing, remain practically unchanged in volume per unit of weight. Cork behaves in a very different manner. If a cylinder of cork is tightly inclosed in a tube in the same manner as the India-rubber which refused to yield to any force, and pressure is applied to it, it is readily and visibly compressed; and when released it expands back to its original volume. In this case a great change in the volume of the material is easily effected.

When cork is subjected to alternate applications and relaxations of pressure, it coincidently contracts and expands. It is this singular property which gives it its value as a means of closing the mouths of bottles. Its elasticity has not only a very considerable range, but it is very persistent. The extent to which the better class of corks used in bottling the effervescent wines will expand the instant they escape from the bottles, is well known. As measured by Mr. Anderson, this expansion amounts to an increase of seventy-five per cent in the volume, even after the corks have been kept under compression for ten years. If the cork be steeped in hot water, the volume will continue to increase till it becomes nearly three times that which the cork occupied in the neck of the bottle.

When cork is subjected to pressure, either in one direction or from every direction, a certain amount of permanent deformation or "permanent set" takes place very quickly. This property is common to all solid elastic substances when strained beyond their limits of elasticity, but with cork the limits are comparatively low; thus, in chemists' and other shops, when a cork is too large to fit a bottle, the shopkeeper gives it a few sharp bites, or squeezes it with pincers to beyond its elastic limits, and so makes it permanently smaller. Besides the permanent set, there is a certain amount of what might be called sluggish elasticity; that is, cork on being released from pressure, springs back a certain amount at once, but the complete recovery takes an appreciable time.

These peculiar and valuable properties of cork are easily explained after examining its structure. The corky part of bark is composed of closed cells exclusively, and this part is developed to a very unusual degree in the cork-oak. A section of cork, taken in the horizontal plane, such as is represented magnified in Fig. 4, microscopically examined, will show that the whole substance is made up of minute. many-sided cells about $\frac{1}{750}$ of an inch in diameter, and about twice as long, the long way of the cells being disposed radially to the trunk. The walls of the cells are extremely thin, and yet they are wonderfully impervious to liquids. Looked at by reflected light, if

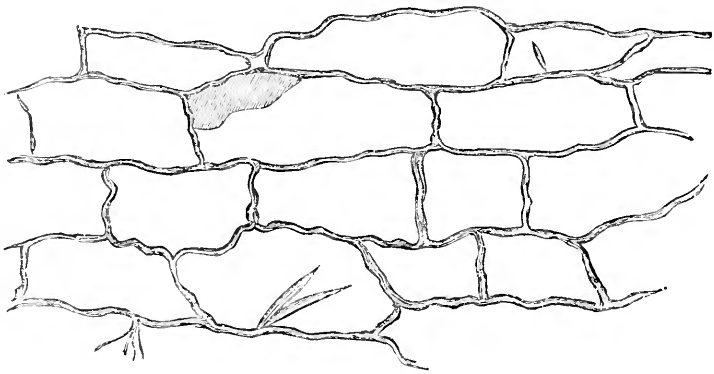

FIG. 4.—CORK, HORIZONTAL SECTION, MAGNIFIED ABOUT 300 DIAMETERS.

the specimen be turned, bands of silvery light alternate with bands of comparative darkness, showing that the cells are built on end to end in regular order. The vertical section (Fig. 5) shows a cross-section of the cells looking like a minute honey-comb. In some specimens large numbers of crystals are found, and are readily distinguished by the aid of polarized light. Minute though they are, they are very numer-

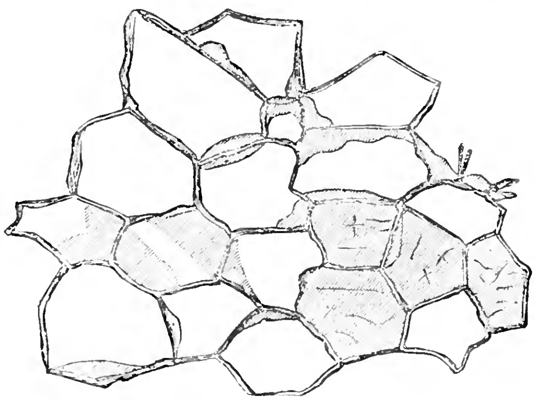

FIG 5.—VERTICAL SECTION.

ous and hard, and it is partly to them that is due the extraordinary rapidity with which cork blunts the cutting-instruments used in shaping it. Cork-cutters always have beside them a sharpening-stone, on which they are obliged to restore the edges of their knives after a very few cuts; and the machines we have described are for the same reason provided with devices for the automatic sharpening of the knives. The cells of the cork are filled with gaseous matter, which Mr. G. H. Ogston has proved by analysis to be common air, and to exist occluded in the cork, to the amount of about fifty-three per cent of its volume. The facility with which this air escapes when placed in an exhausted receiver, is very remarkable when compared with the impermeability of cork to liquids. It is the coexistence of these two properties—that of allowing gases to permeate while completely barring liquids, both of which are easily and clearly demonstrated by suitable experiments—that enables cork to be kept in compression under water or in contact with various liquids without the air-cells becoming water-logged ; and it is the same properties that make cork so admirable an article for water-proof wear, such as boot-soles and hats. By virtue of the combination, it is superior to India-rubber, for it allows ventilation to go on while it keeps out the wet. The cell-walls are so strong, notwithstanding their extreme thinness, that they appear when empty to be able to resist the atmospheric pressure, for the volume of the cork does not sensibly diminish, even when all the air has been extracted. Viewed under very high power, cross-stays or struts of fibrous matter may be distinguished traversing the cells, which, no doubt, add to the strength and resistance of the structure.

We conclude, then, that cork consists practically of an aggregation of minute air-vessels, having very thin, very water-tight, and very strong walls, and hence, if compressed, we may expect the resistance to compression to rise more like the resistance of gases than the resistance of an elastic solid such as a spring. In a spring the pressure increases in proportion to the distance to which the spring is compressed, but with gases, the pressure increases in a much more rapid manner—that is, inversely as the volume which the gas is made to occupy. But, from the permeability of cork to air, it is evident that if subjected to pressure in one direction only, it will gradually part with its occluded air by effusion—that is by its passage through the porous walls of the cells in which it is contained.

On the other hand, if cork be subjected to pressure from all sides, such as operates when it is immersed in water under pressure, then the cells are supported in all directions, the air in them is reduced in volume, and there is no tendency to escape in one direction more than another. An India-rubber bag distended by air bursts if pressed between two surfaces, but if an India-rubber cell be placed in a glass tube and subjected to hydraulic pressure, it is merely shriveled up, the strain on its walls is actually reduced.

To take advantage of the peculiar properties of cork in mechanical applications, it is necessary to determine accurately the law of its resistance to compression. For this purpose, Mr. Anderson introduced a quantity of cork into a strong iron vessel of five and a half gallons capacity, and filled the interstices full of water, carefully getting out all the air. He then proceeded to pump in water, until definite pressures up to one thousand pounds per square inch had been reached, and, at every one hundred pounds, the weight of water pumped in was determined. In this way, after many repetitions, he obtained the decrease of volume, due to any given increase of pressure. The observations have been plotted into the form of a curve (Fig. 6). The

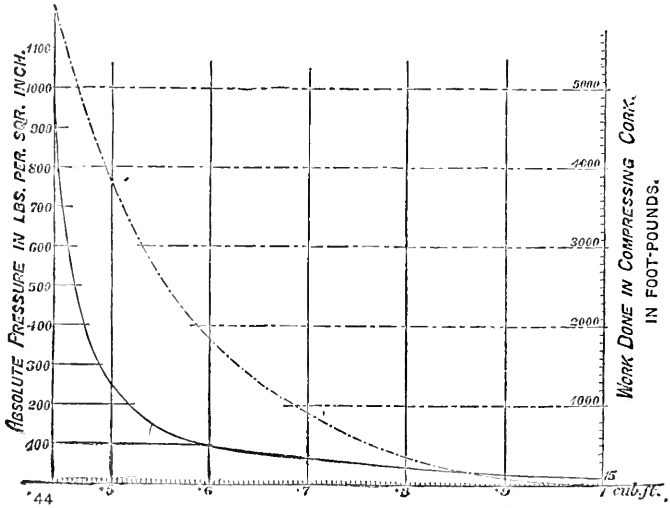


Fig. 6.—Volume of Cork.

base-line represents a cylinder containing one cubic foot of cork, divided by the vertical lines into ten parts; the black horizontal lines according to the scale on the left hand represent the pressures in pounds per square inch which were necessary to compress the cork to the corresponding volume. Thus, to reduce the volume to one half, required a pressure of two hundred and fifty pounds per square inch. At one thousand pounds per square inch the volume was reduced to forty-four per cent; the yielding then became very little, showing that the solid parts of the cells had nearly come together, and this corroborates Mr. Ogston's determination, that the gaseous part of cork constitutes fifty-three per cent of its bulk. The engineer, in dealing with a compressible substance, requires to know not only the pressure which a given change of volume produces, but also the work which has to be expended in producing the change of volume. The work is calculated by multiplying the decrease of volume by the mean pressure per unit of area which produced it. The ordinates of the dotted curve on the diagram with the corresponding scale of foot-pounds on the right-hand side are drawn equal to the work done in compressing a cubic foot of cork to the several volumes marked on the base-line. The author has not been able to find an equation to the pressure-curve; it seems to be quite irregular, and hence the only way of calculating the effects of any given change of volume is to measure the ordinates of the curve constructed by actual experiment. As may be supposed, the pressures indicated by experiment are not nearly so regular and steady as corresponding experiments in a gas would be, and the actual form of the curves will depend on the quality of the cork experimented on.

So far as preservation of elasticity during years of compression is concerned, we have the evidence of wine-corks to show that a considerable range of elasticity is retained for a very long time. With respect to cork subjected to repeated compression and extension, there is very little evidence to be offered beyond this, that cork which had been compressed and released in water many thousand times, had not changed its molecular structure in the least, and had continued perfectly serviceable. Cork which has been kept under a pressure of three atmospheres for many weeks, appears to have shrunk to from eighty to eighty-five per cent of its original volume.

Mr. Anderson has brought under notice two novel applications of cork to the arts :

One is in the water-raising apparatus called a hydraulic ram, the structure of which is shown by Fig. 7. The ram consists of an inclined pipe, A, which leads the water from a reservoir into a chamber, B, which terminates in a valve, C, opening inward. Branching up

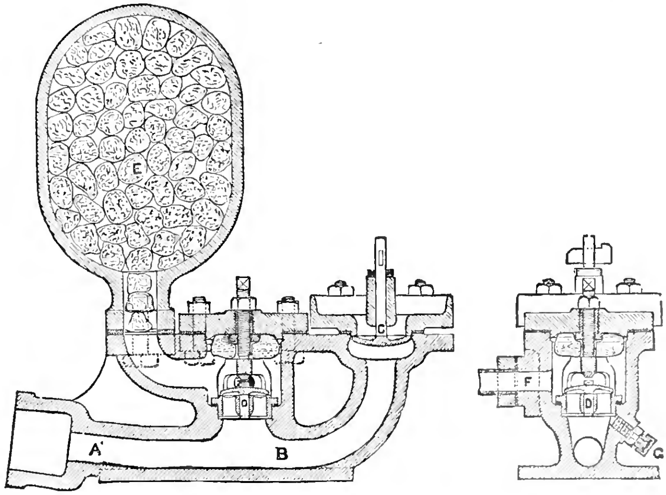


Fig. 7.—Cork in a Hydraulic Ram.

from the chamber is a passage leading to a valve, D, opening outward and communicating with a regulating-vessel, E, which is usually filled with air, but which the author prefers to fill with cork and water. Immediately beyond the inner valve is inserted a delivery-pipe, F, which is laid to the spot to which the water has to be pumped, in this case to the fountain-jet in the middle of this pan.

The action of the ram is as follows : The outer valve C, which opens inward, is, in the first instance, held open, and a flow of water is allowed to take place through it down the pipe and chamber. The valve is then released, and is instantly shut by the current of water which is thus suddenly stopped, and, in consequence, delivers a blow similar to that produced by the fall of a hammer on an anvil, and, just as the hammer jumps back from the anvil, so does the water recoil back to a small extent along the pipe.

During this action, first, a certain portion of water is forced by virtue of the blow through the inner valve D opening outward into the cork vessel, and so to the delivery-pipe, and instantly afterward the recoil causes a partial vacuum to form in the body of the ram and permits the atmospheric pressure to open the outer valve C and re-establish a rush of water as soon as the recoil has expended itself. In the little ram here represented, this action, which it has taken so long to describe, is repeated one hundred and forty times in a minute. The practical action of the ram, as modified by Mr. Anderson, demonstrates that the elasticity of cork is competent to regulate the flow of water. When air is used for this purpose, the air-vessel has to be filled, and, with most kinds of water, the supply has to be kept up while the ram is working, because water under pressure absorbs air. For this purpose a "sniff-valve," G, is a necessary part of all rams. It is a minute valve opening inward, placed just below the inner valve; at each recoil a small bubble of air is drawn in and passed into the air-vessel. This "sniff-valve," is a fruitful source of trouble. Its minuteness renders it liable to get stopped up by dirt; it must not, of course, be submerged, and, if too large, it seriously affects the duty performed by the ram. The use of cork gets rid of all these difficulties, no sniff-valve is needed, the ram will work deeply submerged, and there is no fear of the cork vessel ever getting empty.

The second novel application of cork is for storing a portion of the energy of the recoil of cannon, for the purpose of expending it afterward in running them out.

The result of the explosion of gunpowder in a gun is to drive the shot out in one direction, and to cause the gun to recoil with equal energy the opposite way. To restrain the motion of the gun, "compressors" of various kinds are used, and in this country, for modern guns, they are generally hydraulic, that is to say the force of recoil is expended in causing the gun to mount an inclined plane, and, at the same time, in driving a piston into a cylinder full of water, the latter being allowed to squeeze past the piston through apertures, the areas of which are either fixed, or capable of being automatically varied as the gun recedes; or else the water is driven out of the cylinder through loaded valves. As a rule, the gun is moved out again into its firing position by its weight causing it to run down the inclined plane, up which it had previously recoiled. For naval purposes, however, this plan is inconvenient, because the gun will not run out to windward if the vessel is heeling over, on account of the inclined plane becoming more horizontal, or even inclined in the reverse direction; and should the ship take a permanent list, from a compartment getting full of water, the inconvenience might be very considerable.

In land-service guns, when mounted in barbette, the rising of the gun exposes it and the loading detachment more to the enemy's fire; and in both cases, when placed in ports or embrasures, the ports must be higher than if the gun recoiled horizontally, and will therefore offer a better mark to the enemy's fire, especially that of machine-guns, while the sudden rise of the gun in recoiling imposes a severe downward pressure on the deck or on the platform.

To obviate these disadvantages, the author has contrived the gun-carriage, of which Fig. 8 illustrates the internal construction. The

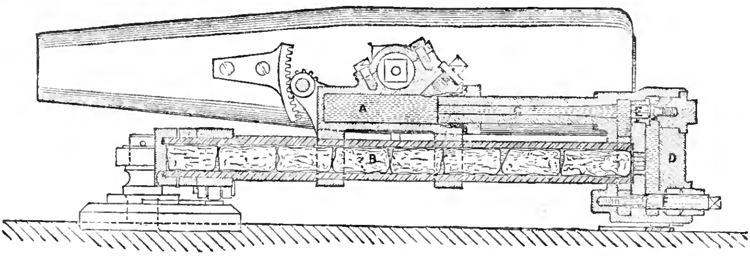


FIG. 8.—CORK BUFFER FOR A GUN.

gun is mounted on a carriage composed of two hydraulic cylinders, A, united so as to form one piece. This carriage slides on a pair of hollow ways, B, and also on to a pair of fixed rams, C, the rear ends of which are attached to the piece D forming the rear of the mounting. There are water-passages down the axes of the rams, and these communicate through an automatic recoil-valve, E, opening from the cylinders, with the two hollow sides B. There is a second communication between the cylinders and slides by means of a cock, F, which can be opened or shut at pleasure. The hollow slides are packed full of cork and water, the latter also completely filling the cylinders, rams, and various connecting passages. By means of a small force-pump, enough water can be injected to give the cork so much initial compression as will suffice to run the gun out when the slides are inclined under any angle which may be found convenient. When the gun is fired, the cylinders A are driven on to the rams C, and the water in the cylinders is forced through the hollow rams into the cork and water vessels formed by the slides B, and the cork is compressed still further. When the recoil is over, the automatic recoil-valve E closes, and the gun remains in its rearward position ready for loading. As soon as loaded, the running-out cock F is opened, the expansion of the cork drives the water from around it into the cylinders, and so forces the gun out. If it be desired to let the gun run out automatically immeniately after recoil, it is only necessary to leave the running-out cock F open, and then the water forced among the cork by recoil returns instantly to the cylinders, and runs the gun out quicker than the eye can follow the motion.

The arrangement adopted may be made by using air instead of cork, but air is a troublesome substance to deal with; it leaks out very easily and without showing any signs of having done so, which might readily lead to serious consequences. A special pump is required to make up loss by leakage.

The merit of cork is its extreme simplicity and trustworthiness. By mixing a certain proportion of glycerine with the water it will not freeze in any ordinary cold weather.

Each of the applications of cork is based on some of the physical or chemical properties of the substance. In bottle-corks its impermeability, elasticity, and imputrescibility are brought into service. Its lightness, the first quality that strikes us, on a superficial view, is not considered.

Cork is used for a variety of other purposes than those which have been mentioned, which, while not so economically important as these, still deserve attention. The male cork, while not well adapted for stoppers, has been made available in the decoration of parks and gardens. Rice-hulling mills have been made from it, but not with much success; small corks can be got out of it. Water-conduits and bee-hives have been constructed from it. It furnishes excellent damp-proof shelves and stands. The Kabyles employ it, mixed with a mortar of mud, in building the walls of their houses, and shingle their roofs with it. It is used for the floats of fish-nets.

These various applications were known, as we learn from expressions of Theophrastus and Pliny, to the Greeks and Romans. Pliny says: "Only that bark is used that is thick and springs back when it is pulled. It is sometimes employed for the buoys of ships' anchors, fishermen's nets, barrel-bungs, and women's winter sandals. The Greeks felicitously called the cork-oak the bark-tree. Cork is used for the covering of roofs." The chips form a good non-conducting material for keeping ice, and reduced to fragments make excellent stable-floors and race-course tracks.

The real, or female cork, has a more homogeneous grain and works much better than male cork. It is a very poor conductor of heat and sound, and has been found valuable to protect hot surfaces against cooling, and to keep frigid substances from melting. It is the basis of several non-conducting mastics and coverings, which are used for protecting pipes, steam-boilers, hot-water reservoirs, etc. Three methods of applying the cork-covering are employed in France. Strips of cork touching at their edges may be laid along the pipes and cylinders and drawn together by wire as in No. 1, Fig. 9. The pipe clothed in this way is a tangent to the inner surface of all the strips, and presents in section a circumference inscribed within a polygon. In the second method, No. 2, thin strips of cork, glued to cloth, by a kind of India-rubber cement, are wrapped spirally round the pipe. The third method consists in employing two hollowed half-cylinders (No. 3) exactly fitting the surface of the pipe. These cylinders, which can be

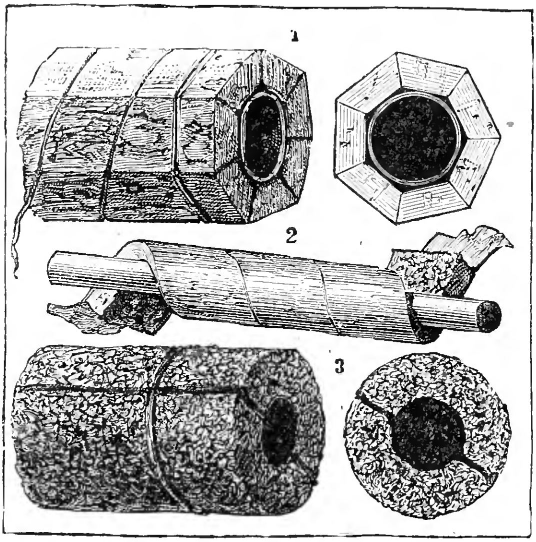


FIG. 9.—PIPES COVERED WITH NON-CONDUCTING CORK. No. 1, bands laid side by side. No. 2, band of cork pasted on cloth and rolled in spiral shape. No. 3, artificial cork.

made of any length, are composed of cork-powder mixed with starch, and are covered with strips of cotton cloth rolled spirally over them, which can be painted with coal-tar or any other suitable paint. Either of the methods will effect a great economy of fuel.

Cork, being also a very poor conductor of sound, is employed successfully in finishing the interior of telephone-cells. It may be put over the doors of consulting-offices; floors made of it are very acceptable in cure-houses and sick-chambers; and it has been adopted in some stringed musical instruments to prevent waste of sound.

Cork has superior buoyant qualities, which are sufficient not only to keep it on the surface, but also to enable it to support tolerably heavy bodies. It is thus employed as a float for night-lamps, for bath-thermometers, and for fish-lines. It is excellently adapted to use in swimming-jackets and life-saving apparatus, in the construction of which inventors have exercised their genius industriously. Many ships carry cork mattresses, which have proved of great service in cases of shipwreck. Life-saving buoys are composed of pieces of cork, are usually in the form of rings, and are furnished with knotted pieces of rope, permitting them to be easily taken hold of. They are also usually covered with painted sail-cloth, to insure their preservation.

By the aid of the weighted floating stakes represented in Fig. 10, it is practicable to rescue a person who has fallen into the water at a short distance from the quay on the shore. The slide allows the cord to be taken between two fingers, and the apparatus to be thrown like a sling. This instrument is composed of a rattan or stick of Malacca-wood, having projecting points, around which lead is melted; the whole is then surrounded with cork chips and covered with cloth and

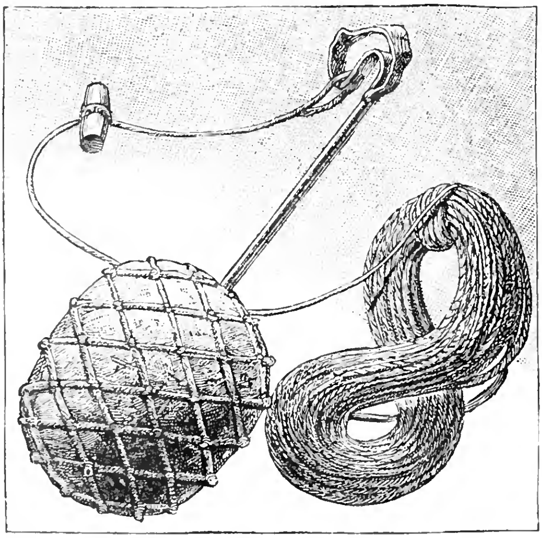

Fig. 10.—Floating Leaded-Stake buoyed with Cork (life-preserver). The apparatus is represented with the line, which is uncoiled when it is thrown into the water.

outside with a network to protect it against friction. Other forms of life-saving apparatus are exemplified in the cork jacket and life-buoy represented in Fig. 11. Rubbers are made of cork inclosed in canvas sacks, and placed along the sides of ships to lessen the shock of their friction against the pier.

The Roman women's custom of wearing cork soles, mentioned by Pliny, has not yet died out, for cork soles are common in the wardrobes of the present day. Cork heels were invented in the time of Louis XV, to be worn inside of the shoe, so as to increase the apparent height of the wearer, without displaying an outer heel. Cork is also useful at the other extremity of the body, shaped into helmets, or as a kind of lining for high hats, or in ventilating-bands, for the protection of the head in hot countries against insolation. Women in the barbarous days, when dead birds were worn in hats, used cork bodies, to which eyes beaks, and features were added, as the molds for their ornithological structures. Trimming-makers use cork molds or bodies, which they cover with silk or cotton to form elaborate ornaments for mantles and cloaks. Cravats and babies' bibs have been made of cork ; and in water-proof garments this material is preferable to India-rubber, in that it allows a freer passage to the air.

Among other miscellaneous applications, may be named those for prosthesis in surgery, naturalists' blocks, rolling-pins for pastry, bath-landings, and wine-labels. The facility with which it is cut, makes cork available for fanciful works of art, as in landscape combinations,

Fig. 11.—Cork Jacket and Life-Buoy.

models of monuments, cases for inclosing bottles to be mailed, spools for silk, the inkstands of our fathers' childhood ; pen-holders, which being large and light, do not cramp the fingers, and hundreds of other articles of the kind. There is hardly a profession that does not make more or less use of cork. Gold-burnishers make their rubbers from it, and crystal-polishers their wheel-surfaces. It forms a very light and convenient mounting for watch-makers' lenses, which is used with a minimum amount of fatigue to the muscles of the eye. Applied as a tire to pulley-wheels, it secures a firmer adhesion of the bands. The stoppers of sucking-bottles have been replaced by cork tips which, being very cheap, can be renewed when the presence of a ferment in them is suspected. Cork is also used in a great many children's toys and plays ; in fixing wigs on the heads of dolls ; in toy guns and pistols ; in shuttlecocks and skittles to be played in rooms. In fact, one is almost tempted to inquire to what use it can not be put.

The manufacture of all these various articles naturally involves the production of considerable quantities of cork-clippings; these, together with the waste incurred in gathering the crop, and with old cast-away corks, constitute the raw material with which a number of important industries are fed. The coarser chips are sought for as packing material for fragile articles, in which their elasticity gives them a peculiar value. The finer particles constitute suberine powders, the balsamic properties of which are well known to hygienists. In treating the rashes of new-born children, they take the place of lycopodium and starch-powders. An insecticide, which is offered under the name of Zifa powder, is composed of cork mixed with phenol. Fire-kindlings have been made of cork-powder, but they do not seem to have given any grand results. The most important application which has been made of cork-refuse is in the manufacture of linoleum. For this fabric, cork-powder is mixed with oxidated linseed-oil. The resultant paste is then spread upon cloth if a carpeting is to be made, or on paper, if hangings are in view. The color, which is a little darker than that of cork, may be enlivened by colored designs. Applied to moist walls as a foundation, or in hangings, linoleum will receive more substantial paintings than wood which warps, or plaster, or other materials, which are liable to crack. Ceilings may be made from it, which can be washed whenever they become soiled or smoked. When used for carpets, linoleum makes the floors quite insonorous, and transforms damp and unhealthy rooms into warm and salubrious habitations. It has the advantage, for kitchens and offices, of not being stained by grease. A new decorative product, lino-burgau, is obtained by fluting linoleum, and by the application of colored varnishes and the metalization of some parts giving beautiful iridescent effects.

A composition of coarse powder of cork and milk of lime, pressed into bricks or tiles, forms an excellent material for the construction of conduits, the lining of damp walls, and for roofs. Lining of the cellars of breweries with these tiles diminishes the melting of the ice; in gunpowder-factories it prevents the deterioration of the powder by damp, and, by virtue of its levity and friability, helps to decrease the damage in case of explosion. Employed as pugging for floors, they destroy the disagreeable resonance. In the spinneries of Alsace and Eastern France, the bricks have proved effective to resist the passage of sound, of heat and cold, and are economical withal.

When distilled in a close vessel, chips and waste of cork give off an illuminating gas, which is capable of shedding a brighter light than coal-gas, and is free from the sulphurous emanations which are so objectionable in that illuminant. When tried for lighting the city of Nérac, the difficulty of providing storage for the immense bulk of chips, needed to furnish the required amount of gas, proved so formidable an obstacle to its general use, that the system had to be given up.

Lastly, the extremely fine and durable paint, cork-black, or Spanish-black, is made from carbonized chips and waste of cork.

## A BOTANICAL BONANZA.

By F. E. BOYNTON.

TAKE a map of the Southern States, and find a point directly northwest of the spot where North Carolina, South Carolina, and Georgia corner. Taking this for a center, describe a circle, whose radius shall extend twenty miles.

Within this bound will be represented a section which probably contains more interesting and rare plants than can be found in any part of the United States occupying the same area.

This district was undoubtedly visited by the elder Michaux. Professor Sargent furnishes me with a short extract from the old botanist's journal, the original of which is in the possession of the Philadelphia Academy of Sciences, in which he describes a trip he made up the Keowee River, and finally up the mountain-streams which form the head-waters of the Keowee. This route naturally led him to pass through the region that I have described. Here it was that *Robinia viscosa* and *Shortia galacifolia* were first found—two plants which were for so long a time thought to be lost species.

Although much of the Alleghany Mountain region has been thoroughly explored by later botanists, this particular spot seems to have been unnoticed until lately—probably on account of its being so difficult to reach from any railroad-station, for the district embraces a very wild and broken mountain-region.

Not far from where I proposed to make the center of our circle, *Rhododendron Vaseyi* grows in profusion. This showy plant is found along an old, long-traveled trail, but was unnoticed until a short time ago. *Tsuga Caroliniana*, the new and rare hemlock, is common on a mountain (Whitesides) which has been visited annually by tourists for half a century, but it remained unnoticed until within a short time. *Robinia viscosa* is a common plant on nearly all the mountain-tops around, but was searched for in vain for nearly a century until it was rediscovered a few years ago. One circumstance, which perhaps helped to obscure it, is that in its natural state it is only a low shrub, not much larger than its near relative, *R. hispida*, with which it is associated, while in cultivation it makes a considerable tree. Professor Sargent, while exploring the head-waters of the Keowee, last September (1886), in search of *Magnolia cordata*, obtained a plant which proved to be the rare *Shortia galacifolia*. Since then it has been found in considerable numbers near where the professor made the discovery.

I will name a few of the interesting if not rare plants that I have collected here during the present season: *Ilex monticola*, *Ilex mollis*, *Gaylussacia ursina*, *Dyrhylleia cymosa*, *Parnassia asanfolia*, and *Drosera rotundifolia*. The little *Houstonia serpyllifolia* grows on the banks of all the mountain-streams, while *H. elongifolia* grows on the drier hill-sides. *Galax aphylla* is interesting to me, on acccount of the beautiful tints which its leaves put on during the winter months, which make it one of the most enlivening features of the landscape during that season. I might fill pages describing plants that occur here, that would be most interesting objects of study to those who have never visited this region; but my principal object in writing this is to suggest the query whether it is not probable that there are undiscovered plants yet to be found in a part of the country which is so virgin and has been so little explored as this.

## SPEECHES AT THE RECENT TYNDALL BANQUET.

By Professors STOKES and TYNDALL, Sir LYON PLAYFAIR, the Earl of DERBY, and Others.

AT the dinner given to Professor Tyndall in London, on the 29th of June, the chairman, Professor Stokes, in proposing the health of the guest of the evening, said: A social gathering like the present is not an occasion on which it is desirable to enter into detail as to the scientific labors of a man, however eminent. Yet the circumstances of the present meeting seem to demand that I should say a few words on some of Dr. Tyndall's researches. Some of his earliest scientific work related to diamagnetism and magnecrystallic action, and in part of this he was associated with the well-known German physicist, Knoblauch. But I can not dwell on these now. And I will even dismiss with this brief mention his researches on the properties of ice and his application of them to the theory of glaciers and the observations which he made in common with his friend and colleague Professor Huxley, whose necessary absence from among us to-night we so much regret. If I be not trespassing too much on the patience of those who listen to me, I would wish to say a little more on that elaborate series of researches, forming no less than six separate papers in the "Philosophical Transactions" in which Dr. Tyndall investigated the relation of simple and compound gases and of vapors to radiant heat, especially radiant heat from sources at a moderate temperature. According to his researches, while the main constituents of the earth's atmosphere, nitrogen and oxygen, are practically diathermous, at least with regard to radiations which can traverse rock-salt, as we know that by far the greater part of those that we have to deal with can, such is far from being the case with other gases equally transparent with regard to light. Dr. Tyndall found that as a rule the more complex the composition of a gas the greater is its defect of diathermancy. To confine ourselves to the two gases which occur in the atmosphere mixed with its main constituents —I allude of course to carbonic acid and to water in the gaseous state of vapor—he found that both, especially the latter, which likewise is present in by far the larger quantity, are very distinctly defective in diathermancy, and he concluded that the main part of the absorption of solar heat in passing through the atmosphere, absorption as distinguished from scattering, is due to the watery vapor which it contains. From this result he drew important inferences as to atmospheric temperature and climatological conditions. Dr. Tyndall's researches on the relation of gases to radiant heat came naturally before me during my long tenure of office as one of the Secretaries of the Royal Society; and for my own part I may say that it seemed to me all along that the results were established on so firm a basis, and the conclusions regarding the invisible radiations were so perfectly analogous to what we know to be true regarding the visible ones, where the investigation is comparatively easy, that the work bore on it the stamp of truth. The conclusions were not, however, accepted without opposition. In the late Professor Magnus, Dr. Tyndall met a foeman worthy of his steel; a foeman, however, only in the sense of an intellectual athlete; for socially I doubt not they were the firmest friends, and their friendship was even cemented by the fact that they were both alike seeking after truth in a similar subject. But truth only gains by opposition: its defenders are led to engage in fresh researches, which end in strengthening its foundations. I think that the validity of Dr. Tyndall's results is now generally admitted. If some hesitation is still felt, it arises mainly, I think, from misconception; from imagining that assertions which were meant to apply only to heat-rays of such refrangibilities as to be absorbed by water were meant to be affirmed of the invisible radiations generally which lie beyond the extreme red. The time reminds me that I must only very briefly refer to another investigation in which Dr. Tyndall has more recently been engaged, and of which the interest is biological, while the means of investigation are physical; I allude, of course, to the question of abiogenesis. Here, again, Dr. Tyndall was working on contested ground, and the objections of opponents stimulated him to fresh inquiries, which resulted in the continual strengthening of his negative conclusions. In the course of his work he was led, for instance, to the discovery of the great difference which exists between the germs of microscopic creatures and the creatures themselves, in relation to their power of resisting the destructive influence of a high temperature. This discovery not only detected a source of error in some experiments which had seemed to favor the hypothesis of abiogenesis, but threw important light on the conditions which must be fulfilled in order to secure complete sterility. But original research is not the only way in which a man can advance the cause of science. All-important though it is, it nevertheless often happens that an original investigation is too abstruse to be followed by more than a few experts; nor is it by any means necessarily the case that an eminent investigator is equally successful in expounding to others, especially to a mixed audience, the results at which he himself or other investigators may have arrived. The general diffusion of science depends largely on the clearness with which its leading principles and results are expounded, whether by lectures or by treatises, in which, while they are scientifically sound, popularity of style and general readableness are not sacrificed to the dry exactness of scientific detail. Most of us have had opportunities, whether at the Royal Institution, with which the name of Tyndall has so long been connected, or elsewhere, of being impressed with the singularly lucid style and graphic expression with which he expounded to his audience the salient points of the scientific subject which he brought before them. Nor was it only in clearness of verbal exposition that he excelled; the manipulative skill with which his original investigations were carried on served him in good stead in his more popular expositions; and by the aid of that "domestic sun," which even the murky atmosphere of a London winter could not obscure, he was enabled in very many cases to exhibit to the audience the actual results of experiments which had first been carried out in the quiet of the laboratory. Nor is it our own countrymen alone who have had the benefit of Dr. Tyndall's lucidity of exposition. Our friends across the ocean have flocked to hear and have appreciated the lectures which he has there delivered as a free gift to transatlantic science. But oral lectures, after all—the lectures at least of one individual—can only reach a fraction of the community; nor do they admit of that pause for thought which the learner requires in endeavoring to make himself master of a new subject. But the same qualities of mind which enable a man to be a clear and interesting lecturer fit him also to be the author of eminently readable books; and for the general diffusion of science which is taking place we owe much to the writings of Dr. Tyndall.

### PROFESSOR TYNDALL'S SPEECH.

Mr. President, my Lords, and Gentlemen: When the project of a dinner was first mentioned to me by a very old and steadfast friend of mine, who, to my regret and his, is not here to-night, had any dream, or vision, of the assembly now before me risen on my mind's eye, I should have declined the risk of standing in my present position; for I should have doubted, as I still continue to doubt, my ability to rise to the level of the occasion. Gratitude, however, is possible to all men; and I would offer you, sir, my grateful thanks for the manner in which you have proposed this toast; I would thank with equal warmth an assembly which, in intellectual measure, is, probably, as distinguished as any of the same size ever addressed by man, for the way in which they have received it; and I would extend my thanks to my friends of the Department of Science and Art, for their spontaneous kindness to an old colleague, who for many years lent his humble aid to the department in diffusing sound scientific knowledge among the masses of the people. My own scientific education began late. It had, of necessity, to be postponed until after I had reached the age of seven or eight and twenty. Notwithstanding this drawback, in learning, teaching, and working in the laboratory, I have been permitted to enjoy a spell of thirty-nine years. In 1850, during a flying visit from Germany to England, I stood, for the first time, in the bright presence of Faraday. In February, 1853, I gave my first Friday evening lecture in the Royal Institution; and three months afterward, on the motion of Faraday, the old chair of Natural Philosophy, which had been filled at the beginning of the century by Thomas Young, was restored, and to it I was elected. It causes me genuine pleasure to think that I shall be succeeded in that chair by so true and so eminent a man of science as Lord Rayleigh.

It is not my intention to overburden you with egotism to-night; but, casting an earnest glance back upon the past, a few words seem due from me to the memory of one or two of the group of good men, no longer with us, with whom I was so intimately associated. Regarding Faraday, I will confine myself to stating that years have not altered my estimate of the beauty and the nobleness of his character. He was the prince of experimental philosophers; but he was more than this—in every fiber of his mind he was a gentleman. It is, however, of two of our honorary secretaries that I wish now to speak; premising that, for the first seven years of my life in the Royal Institution, the post of honorary secretary was held by a cultivated and very worthy gentleman, the Rev. John Barlow. From 1860 to 1873—that is, for a stretch of thirteen memorable years—I had the happiness of working hand in hand with Dr. Bence Jones. Never in my experience have I met a man more entirely and unselfishly devoted to the furtherance of scientific work. I hardly like to mention the following incident, because it furnishes but a scanty measure of his devotion. On one occasion I was in need of funds to carry out some experiments of a delicate and costly character. Bence Jones came to me, and after some hesitation—for he knew that money was likely to raise a difficulty between us—he said, with earnestness: "Dear Tyndall, behave as my friend; do me the favor and the honor of devoting this to your investigation. There is more, if you need it, where that came from." He handed me a check for £100. Had I asked for £1,000, he would have given it to me, and the world, as far as he was concerned, would have been none the wiser. Bence Jones was a strong man, and liked to have his own way. At first, as was natural, we sometimes surged against each other; but these little oppositions were rapidly adjusted, and for many years before his death the tie of brother to brother was not truer or tenderer than that which united myself and Bence Jones. On my return from the United States I found him dying. In fact, the knowledge of his condition caused me to take leave, earlier than I otherwise should have done, of a people that I had learned to trust and love. Soon after my return I saw him lowered into the grave.

The death of Bence Jones, whose steadfast loyalty to the Institution he loved so well, showed itself to the last, was a sore calamity to be met. At that time one man only seemed fitted to supply his place. That man was the beloved and lamented William Spottiswoode. To him I appealed to stand by the Institution at a critical hour of its fortunes. He had his own mathematical work on hand, and he was too well acquainted with the duties of our honorary secretaryship to accept them lightly. After much reflection, he wrote me a letter regretfully but distinctly declining the office. But he reflected a second time. He knew that his refusal would cause me pain, and his affection for me prevailed. When, therefore, the letter of refusal—for he sent it to me—came, it was accompanied by a second letter, canceling the refusal and accepting the post. With William Spottiswoode I had the happiness of working in close companionship for six years. The diligence, wisdom, and success with which he discharged his onerous duties—the princely hospitality which shed a glow upon the office while he held it—are well remembered. Of the dignity with which he afterward filled the high position now occupied by the illustrious man who presides here this evening it is needless to speak. Him also we have seen lowered to his rest, amid the grief of friends assembled to do honor to his memory. Such were the men who served the Royal Institution in the past; and their example has been worthily followed by other men of eminence, still happily among us. Never was an institution better served than the Royal Institution, and not by its honorary secretaries alone. With singleness of purpose and purity of aim, its successive presidents, boards of managers, and honorary treasurers have unswervingly promoted the noble work of investigation and discovery. May they never lower the flag which, for well-nigh a century, they have kept victoriously unfurled!

The year after my appointment I was called upon to deliver, in conjunction with Dr. Whewell, Faraday, Sir James Paget, and some other eminent men, one of a series of lectures on scientific education. I then referred with serious emphasis to the workers in our coal-mines, and to the terrible perils of their occupation. I pointed to the intellectual Samsons toiling with closed eyes in the mills and forges of Manchester and Birmingham, and I said, "Give these toilers sight by the teachings of science, and you diminish the causes of calamity, multiply the chances of discovery, and widen the prospect of national advancement." Thus early, you will see, I was alive to the importance of technical education; and I am no less alive to it now. You will not, therefore, misunderstand me when I say that to keep technical education from withering, and to preserve the applications of science from decay, the roots of both of them must be well imbedded in the soil of original investigation. And here let it be emphatically added, that in such investigation practical results may enter as incidents, but must never usurp the place of aims. The true son of science will pursue his inquiries irrespective of practical considerations. He will ever regard the acquisition and expansion of natural knowledge—the unraveling of the complex web of Nature by the disciplined intellect of man—as his noblest end, and not as a means to any other end. And what has been the upshot of science thus pursued? Why, that the investigator has over and over again tapped springs of practical power which otherwise he would never have reached. Illustrations are here manifold. I might point to the industries which affiliate themselves with Faraday's discovery of benzol, and with his discovery of the laws of electrolysis. But I need not go further than the fact that in this our day a noble and powerful profession has been called into existence by his discovery of magneto-electricity. The electric lamps which mildly illuminate our rooms, the foci which flood with light of solar brilliancy our railway-stations and public halls, can all be traced back to an ancestral spark so small as to be barely visible. With impatient ardor Faraday refused to pause in his quest of principles to intensify his spark. That work he deliberately left to others, confidently predicting that it would be accomplished. And, prompted by motives both natural and laudable, but which had never the slightest influence on Faraday, others have developed his spark into the splendors which now shine in our midst.

It would be a handsome jubilee present, if it were a possible one, to roll up the career of Faraday into portable form, and to offer it to the Queen as the achievement of one of Her Majesty's most devoted subjects during her own reign. Faraday's series of great discoveries, however, began in 1831, which throws his work five or six years too far back. During the rest of his fruitful life he was a loyal son of the Victorian epoch. But, passing beyond the limitations of the individual, what is science, as a whole, able to offer, on the golden wedding of the Queen with her people? A present of the principle of gravitation—a handing over to Her Majesty of the bit and bridle whereby the compelling intellect of Newton brought the solar system under the yoke of physical laws—would surely be a handsome offering. I mention this case of known and conspicuous grandeur, in order to fix the value of another generalization which the science of her reign *can* proudly offer to the Queen. Quite fit to take rank with the principle of gravitation—more momentous if that be possible—is that law of conservation which combines the energies of the material universe into an organic whole; that law which enables the eye of science to follow the flying shuttles of the universal power, as it weaves what the Earth Spirit in "Faust" calls "the living garment of God." This, then, is the largest flower of the garland which the science of the last fifty years is able to offer to the Queen.

The second generalization is like unto the first in point of importance, though very unlike as regards its reception by the world. For whereas the principle of conservation, with all its far-reaching, and, from some points of view, tremendous implications, slid quietly into acceptance, its successor evoked the thunder-peals which it is said always accompany the marriage of thought and fact. For a long time the scent of danger was in the air. But the evil odor has passed away; the air is fresher than before; it fills our lungs and purifies our blood, and science, in its jubilee offering to the Queen, is able to add to the law of Conservation the principle of evolution.

In connection with these victories of the scientific intellect, I have mentioned neither persons nor nationalities—holding, as Davy expressed it, when the Copley medal was awarded to Arago, that "science, like Nature, to which it belongs, is neither limited by time nor space. It belongs to the world, and is of no country and no age." Still, it will not be counted Chauvinism, if I say that in the establishment of these two great generalizations Her Majesty's subjects have quitted themselves like men. With regard to a third generalization, neither England nor Germany has been idle. Omitting the name of many a noble worker in both countries, the antiseptic system of surgery assuredly counts for something in the civilized world. And yet it is but a branch of a larger generalization, of momentous import, which in our day has been extended and consolidated to an amazing degree by a Gallic investigator. To some, however, any flower culled in this garden will be without odor. Let me therefore add a sweet-scented violet under the name of spectrum analysis which, besides revealing new elements in matter, enables the human worker to stretch forth his hand to sun and stars, to bring samples of them, as it were, into his laboratory, and to tell us, with certainty, whereof they are composed. Surely all these, and other discoveries of high importance, taken and bound together, form an intellectual wreath, not unworthy of Her Majesty's acceptance in her jubilee year.

A short time ago an illustrious party leader summed up the political progress of the Queen's reign. What I have said will, I trust, show that the intellectual world is not entirely compounded of party politics—that there is a band of workers scattered over the earth whose arena is the laboratory rather than the platform, and who noiselessly produce results as likely to endure, and as likely to influence for good the future of humanity, as the more clamorous performances of the politician.

One word more. On the Continent of Europe, kings had been the nursing fathers and queens the nursing mothers of science; while republican governments were not a whit behind in the liberality of their subventions to scientific education. In England we had nothing of this kind, and to establish an equivalent state of things we had to appeal, not to the Government, but to the people. They have been roused by making the most recondite discoveries of science the property of the community at large. And as a result of this stirring of the national pulse—this development of self-reliance—we see schools, colleges, and universities now rising in our midst, which promise by-and-by to rival those of Germany in number and importance.

It is time that I should cease; but, before doing so, I would ask—as they do in the House of Commons—permission to say a word in personal explanation. I have climbed some difficult mountains in my time, and after strenuous effort for a dozen hours or more upon ice, rock, and snow, I have not unfrequently reached the top. I question whether there is a joy on earth more exhilarating than that of the mountaineer, who, having achieved his object, is able to afford himself, upon the summit, a foaming bumper of champagne. But, my lords and gentlemen, the hardest climb, by far, that I have ever accomplished, was that from the banks of the Barrow to the banks of the Thames—from the modest Irish roof under which I was born to Willis's Rooms. Here I have reached my mountain-top, and you—God bless you!—have given me a bumper which no scientific climber ever before enjoyed.

AFTER-SPEECHES.

*Sir Frederick Pollock*, in proposing the toast of "Literature and Art," said that on most occasions similar to the present one this toast was a triple one, and included the three sisters—Science, Literature, and Art. But this evening they were assembled together to do homage to science, in the person of one of its most distinguished votaries, and for the time the room in which they had met became a temple of science. In such a temple the principal figure, standing upon the pedestal appropriated to the presiding goddess, must be that of Science, and to her due rites had been already rendered. But for the sisters, Literature and Art, room must be found also in the sacred edifice; they too must have their altars and their shrines. He pointed out that the highest powers of the imagination were required by the man of science, as well as by the poet and the painter, and instanced the prediction by Fresnel of the bright spot in the center of the shadow of a disk; and the suggestion made to Goethe of his theory of the development of the vertebrate skeleton, by his accidental observation of the scattered fragments of the deer's skull lying in his path. He adduced the names of Aristotle, Bacon, and other great men who had connected literature with science; and instanced Leonardo da Vinci and Sir Christopher Wren, one of the founders of the Royal Society, as linking together science and art. He accordingly had great pleasure in submitting for acceptance "Literature and Art," coupling with it the name of Lord Lytton, who was not only a distinguished representative of modern literature, but had also a distinct hereditary claim to represent that of the last generation; and Sir Frederick Leighton, the distinguished President of the Royal Academy.

*The Earl of Lytton.*—In returning thanks for "Literature" upon an occasion when we are all met to honor science in the person of one of its most illustrious adepts, I can not but forcibly remember that we are living in an age when inquiry is more active and more wide-spread than conviction, and it is natural that in minds of the highest order under these conditions even the imaginative faculty should be more powerfully attracted to scientific research than to purely literary production. But inquiry, I think, would be very sterile if conviction in some form or another were not the ultimate fruit of it, and I think that for a period of really vigorous, creative, imaginative art, we must look forward, in the course of scientific research, to some such general resettlement of ideas upon the basis of a common conviction—which is not now, perhaps, altogether attainable—as may enable art, instead of representing, as it does now, merely the mental attitude of the individual poet or the individual painter, once more to become the universally spontaneous and universally recognized imaginative expression of ideas and emotions which are common to a whole generation or a whole community. If that is the case, if science is ultimately to render this great service to literature and art, surely, in the mean while, we can not but gratefully appreciate the literary labors of those men of science who, in our own and in other countries, are promoting, or have promoted, this result, not only as original discoverers, but also as popular and powerful interpreters of scientific fact, and who, in this latter capacity, have already enriched contemporary literature with writings of rare literary value. If, instead of returning thanks for literature, I were permitted to return thanks on behalf of literature to those writers who have powerfully influenced my own generation, not only by thoughts which stimulate and instruct the intellect, but also by words which stir and elevate the heart, then assuredly I should ask leave to mention some distinguished names which occupy in the field of literature a position only second to the high rank they hold in the hierarchy of science; and foremost among those names I should not hesitate to mention with a special personal gratitude the name of the illustrious man who is the honored guest of this great assembly to-night. I can not say it is as a student of science that I myself have studied the writings of Professor Tyndall, but this I can say, and most truly, that those writings have been to me, from a very early period of my life, companions so cherished that I learned to look upon their writer as a dear personal friend and benefactor long before it was my privilege to be admitted to his personal intimacy. I believe that scientific research has succeeded in establishing on a physiological basis certain evidences of intelligence even among oysters; and certainly there is, I think, one form of intelligence which is conspicuously displayed by the oyster which might, perhaps, be cultivated with advantage by after-dinner speakers in my position. The oyster knows when to shut up. Admonished by that very interesting and suggestive fact in natural history, what little else I have to say upon behalf of literature, I shall confine to the expression of a hope that the well-deserved relaxation from his more systematic scientific labors in connection with the Royal Institution may enable my valued and honored friend Professor Tyndall to enjoy an increased leisure for the continued cultivation of that department of literature which has already been so richly adorned by his admirable writings."

*Sir Lyon Playfair, M. P.*, proposed the next toast, "The Public Services in Relation to Science." He said that undoubtedly the public services were intimately connected with science, and were profoundly affected by its progress, but, unfortunately, the truth was only beginning to be recognized in this country. In the United States scientific men were attached to all public offices, but in this country the attachment was of the loosest possible character. Nevertheless, science had undoubtedly affected our public services in the most profound way. The telegraph had altered the whole system of commerce, and also the methods and the powers of government. There was to be a great naval review next month; it would be interesting to imagine Elizabeth's thirty small ships, which conquered the Armada, sailing through two miles of modern ironclads. The largest piece of ordnance used in the Crimean War cost less than a single shot fired from the huge guns of our ironclads. But it was in peace rather than in war that science rejoiced in aiding government. A strong feeling was arising that we must improve our intellectual position as a nation, and this, at last, was being recognized by the Government. A material index of progressive civilization had always been desired. Liebig contended that the best index of civilization was the quantity of soap consumed. When the Queen ascended the throne we consumed per head $7\frac{3}{4}$ pounds of soap, and now we use 10 pounds per head. The consumption of paper was a more reliable index. At the commencement of the Queen's reign the consumption was $1\frac{1}{4}$ pound of paper yearly; now it was 12 pounds, while in the United States it was 10 pounds, in Germany 9 pounds, in France 8 pounds, and in Italy 4 pounds. But the main question was whether we were developing the national intellect at the same rate as other nations. Our general intelligence is still high, but our trained scientific intelligence is low. Our secondary education in all matters relating to science was far behind that of the United States, Germany, and France. Neither the Government nor the people governed could go on in simple faith on our practical aptitudes by relying on a blind and vain empiricism, like a tree severed from its roots.

*The Earl of Derby.*—"MY LORDS AND GENTLEMEN: You have asked me to return thanks on behalf of the public services in connection with science, and Sir L. Playfair, in relation to that toast, has referred to the increased consumption of soap in this country. I have attended a good many public dinners, and I must say that the expenditure of what is vulgarly called soft soap has been great this evening. I am sincerely grateful to him for the quantity of that article which it has pleased him to expend upon me. But really the toast is one which hardly any man is competent to do justice to, and certainly not one who, like myself, has no connection with science, except a sincere admiration and respect for its professors, and whose connection with the public service has only been that of a parliamentary chief. Under our system the parliamentary head of a department is mainly concerned to keep it in harmony with the House of Commons and with the public. He has to warn the permanent officials that something that is done, or something that is left undone, or proposed to be left undone, is what public opinion will resent; and, on the other hand, he has to tell outsiders that the things they ask him and press him to do are things unwise or impossible from an administrative point of view. That is useful; it is certainly laborious, and it is often a difficult function; but it does not involve much more scientific knowledge than is implied in driving a cab through a crowded street. It does require some knowledge of men, but that is a department of study to which, as yet, no scientific formula has been found to apply. Sir L. Playfair told us, and I was sorry to hear it, of the loose connections which exist between science and the Government. I can only say that I am entirely ignorant of any such immoral transactions. But if the departments were better represented here, and if they could speak for themselves, I am sure that they would not be backward in acknowledging their obligations to science. The Treasury would tell you that those useful though sometimes ungraceful coins in which our dinner is paid for would not circulate through Europe as they do if they had not been subjected to a careful and complicated process, requiring scientific knowledge. The Excise might tell you, if they chose, of the frauds that might be perpetrated upon the revenue and the public if it were not for the careful and scientific examination of all taxable articles. The Post-Office would find no difficulty in acknowledging its obligations to Watt and to Stephenson—for where would postal revenue be without railways?—and in later days to investigators whose researches made the telegraph possible. But the fighting departments, or the spending departments, which is their more common name in Downing Street, would have the most to return thanks for. They would point to the modern ironclad, the most elaborate, the most complete, and the most costly, of all contrivances in which the art of construction has been utilized for purposes of destruction. They would tell you how the chemist, metallurgist, the engineer, the electrician, the mathematician, have all contributed their share to that extraordinary result of science and skill. The War-Office would follow the Admiralty. They would not say, as Frederick of Prussia did, that Providence is on the side of the biggest battalions, but they might possibly say that Providence was generally on the side of the army which could bring into the field the most scientifically effective weapon in the hands of the most carefully-trained soldier. If I were to turn to the line of business with which I had once something to do, I might ask any diplomatist or any statesman to explain to you how largely the position of Egypt, and, with that, the diplomacy of Europe, has been affected by that little scratch which the genius of M. de Lesseps drew across the Egyptian sands; and if, as is quite possible, the coal-carrying power of steamers and their speed and their economy are largely increased—I do not speak of those wilder predictions according to which steam is to be superseded as the motor power by something more efficient—suppose, I say, the large increase of the coal-carrying power of steamers, and the results to which I have referred may be again reversed; and again, at least in war-time, the route to India may lie through the South African seas. If I speak of the colonies, every one conversant with that department would admit that if we had had the ocean telegraph in existence twenty-five years ago half our little wars beyond the seas would never have taken place, and those that have taken place would have been disposed of in half the time. I know that these things are commonplace, but I can not help that. If I could tell you what the next great discovery was going to be, that would not be commonplace. But, unfortunately, that is not in my power; and if it were, I do not think I should be in a hurry about it, because I have observed that those who are the first to announce a discovery are generally rewarded by having a remarkably unpleasant time. But however great may be the gains which we have derived from the applications of science, they are nothing as compared with those which will and do accrue to us from the acceptance of scientific habits of thought. That is coming already, and it will come more in a not remote future. We have many things in this age and country of which we can not boast, but we may boast that in science England has done something more than hold her own. The great name of Darwin will survive, it may be, the British Empire itself, and with him will be remembered some others also, whom to single out might, perhaps, be invidious. But we may be sure of this, that among their names will be included the name of our distinguished guest of to-night. It is a common complaint that politicians have done nothing for science. In that I do not agree. They have done the best they could for it—they have let it alone; they have not corrupted it by their intrigues, nor vulgarized it by their squabbles; and they being what they are, and science being what it is, that is probably the best service they could have rendered it.

## SOME HUMAN INSTINCTS.*

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II

In a previous article I passed in review a certain number of those instincts which may be considered fundamental in man. In the pages which follow I propose to complete the list. The reader will perhaps remember my main thesis, which is that man, so far from having an unusually small number of instincts, is more richly endowed in this respect than any other mammal; so richly, indeed, that his instincts often block one another's path. This phenomenon, combined with the transitoriness of many of them, and with what I have called the law of inhibition of instincts by habits, sufficiently account for the indeterminateness of man's conduct in presence of the same objective stimuli—an indeterminateness which has usually been supposed incompatible with his possession of any instincts at all.

The last instinct I touched upon was fear. Let me next say a few words about *appropriation* or *acquisitiveness*. Once more the reader will remember that an instinct is nothing more than an inborn path of reflex discharge in the nervous centers, such that a certain sort of object falling on the senses awakens an impulse to act in a determinate way. The beginnings of acquisitiveness are seen in the impulse which very young children display to snatch at, or beg for, any object which pleases their attention. Later, when they begin to speak, among the first words they emphasize are "me" and "mine."† Their earliest quarrels with each other are about questions of ownership; and parents of twins soon learn that it conduces to a quiet house to buy all presents in impartial duplicate. Of the later evolution of the proprietary instinct I need not speak. Every one knows how difficult a thing it is not to *covet* whatever pleasing thing we see, and how the sweetness of the thing often is as gall to us so long as it is another's. When

* See "The Popular Science Monthly" for June, 1887.

† I lately saw a boy of five (who had been told the story of Hector and Achilles) teaching his younger brother, aged three, how to play Hector, while he himself should play Achilles, and chase him round the walls of Troy. Having armed themselves, Achilles advanced, shouting "Where's my Patroklos?" Whereupon the would-be Hector piped up, quite distracted from his *rôle*, "Where's *my* Patroklos? I want a Patroklos! I want a Patroklos!"—and broke up the game. Of what kind of a thing a Patroklos might be he had, of course, no notion—enough that his brother had one, for him to claim one too.

another is in possession, the impulse to appropriate the thing often turns into the impulse to harm him—what is called *envy*, or *jealousy*, ensues. In civilized life the impulse to own is usually checked by a variety of considerations, and only passes over into action under circumstances legitimated by habit and common consent, an additional example of the way in which one instinctive tendency may be inhibited by others. A variety of the proprietary instinct is the impulse to form collections of the same sort of thing. It differs much in individuals, and shows in a striking way how instinct and habit interact. For, although a collection of any given thing—like postage-stamps—need not be begun by any given person, yet the chances are that if accidentally it *be* begun by a person with the collecting instinct, it will probably be continued. The chief interest of the objects, in the collector's eyes, is that they are a collection, and that they are his. Rivalry, to be sure, inflames this, as it does every other passion, yet the objects of a collector's mania need not be necessarily such as are generally in demand. Boys will collect anything that they see another boy collect, from pieces of chalk and peach-pits up to books and photographs. Out of a hundred students whom I questioned, only four or five had never collected anything. In "The Nation" for September 3, 1886, Professor G. S. Hall gives some account of a statistical research on Boston school-boys, by Miss Wiltse, from which it appears that only nineteen out of two hundred and twenty-nine had made no collections.

The associationist psychology denies that there is any blind primitive instinct to appropriate, and would explain all acquisitiveness, in the first instance, as a desire to secure the "pleasures" which the objects possessed may yield; and, secondly, as the association of the idea of pleasantness with the *holding* of the thing, even though the pleasure originally got by it was only gained through its expense or destruction. Thus the miser is shown to us as one who has transferred to the gold by which he may buy the goods of this life all the emotions which the goods themselves would yield; and who thereafter loves the gold for its own sake, preferring the means of pleasure to the pleasure itself. There can be little doubt that much of this analysis a broader view of the facts would have dispelled. "The miser" is an abstraction. There are all kinds of misers. The common sort, the excessively niggardly man, simply exhibits the psychological law that the potential has often a far greater influence over our mind than the actual. A man will not marry now, because to do so puts an end to his indefinite potentialities of choice of a partner. He prefers the latter. He will not use open fires or wear his good clothes, because the day may come when he will have to use the furnace or dress in a worn-out coat, "and then where will he be?" For him, better the actual evil than the fear of it; and so it is with the common lot of misers. Better to live poor now, with the *power* of living rich, than to live rich at the risk of losing the power. These men value their gold, not for its own sake, but for its powers. Demonetize it, and see how quickly they will get rid of it! The associationist theory is, as regards them, entirely at fault.

With other misers there combines itself with this preference of the power over the act the far more instinctive element of the simple collecting propensity. Every one collects money, and when a man of petty ways is smitten with the collecting mania for this object he necessarily becomes a miser. Here again the associationist psychology is wholly at fault. The hoarding instinct prevails widely among animals as well as among men. Professor Silliman has thus described one of the hoards of the California wood-rat, made in an empty stove of an unoccupied house: "I found the outside to be composed entirely of spikes, all laid with symmetry, so as to present the points of the nails outward. In the center of this mass was the nest, composed of finely-divided fibers of hemp-packing. Interlaced with the spikes were the following: about two dozen knives, forks, and spoons; all the butcher's knives, three in number; a large carving-knife, fork, and steel; several large plugs of tobacco, . . . an old purse containing some silver, matches, and tobacco; nearly all the small tools from the tool-closets, with several large augers, . . . all of which must have been transported some distance, as they were originally stored in different parts of the house. . . . The outside casing of a silver watch was disposed of in one part of the pile, the glass of the same watch in another, and the works in still another."*

In every lunatic asylum we find the collecting instinct developing itself in an equally absurd way. Certain patients will spend all their time picking pins from the floor and hoarding them. Others collect bits of thread, buttons, or rags, and prize them exceedingly. Now, the "miser" *par excellence* of the popular imagination and of melodrama, the monster of squalor and misanthropy, is simply one of these mentally deranged persons. His intellect may in many matters be clear, but his instincts, especially that of ownership, are insane, and their insanity has no more to do with the association of ideas than with the precession of the equinoxes. As a matter of fact his hoarding usually is directed to money; but it also includes almost anything besides. Lately in a Massachusetts town there died a miser who principally hoarded newspapers. These had ended by so filling all the rooms of his good-sized house from floor to ceiling that his living space was restricted to a few narrow channels between them. Even as I write, the morning paper gives an account of the emptying of a miser's den in Boston by the City Board of Health. What the owner hoarded is thus described: "He gathered old newspapers, wrapping-paper, incapacitated umbrellas, canes, pieces of common wire, cast-off clothing, empty barrels, pieces of iron, old bones, battered tin-ware,

* Quoted in Lindsay, "Mind in Lower Animals," vol. ii, p. 151.

fractured pots, and bushels of such miscellany as is to be found only at the city 'dump.' The empty barrels were filled, shelves were filled, every hole and corner was filled, and in order to make more storage-room, 'the hermit' covered his store-room with a network of ropes, and hung the ropes as full as they could hold of his curious collections. There was nothing one could think of that wasn't in that room. As a wood-sawyer, the old man had never thrown away a saw-blade or a wood-buck. The bucks were rheumatic and couldn't stand up, and the saw-blades were worn down to almost nothing in the middle. Some had been actually worn in two, but the ends were carefully saved and stored away. As a coal-heaver, the old man had never cast off a worn-out basket, and there were dozens of the remains of the old things, patched up with canvas and rope-yarns, in the store-room. There were at least two dozen old hats, fur, cloth, silk, and straw," etc. Of course there may be a great many "associations of ideas" in the miser's mind about the things he hoards. He is a thinking being, and must associate; but, without an entirely blind impulse in this direction behind all the ideas, such practical results could never be reached.*

*Kleptomania*, as it is called, is an uncontrollable impulse to appropriate, occurring in persons whose "associations of ideas" would naturally all be of a counteracting sort. Kleptomaniacs often promptly restore, or permit to be restored, what they have taken; so the impulse need not be to keep, but only to take. But elsewhere hoarding complicates the result. A gentleman, with whose case I am acquainted, was discovered, after his death, to have a hoard in his barn of all sorts of articles, mainly of a trumpery sort, but including pieces of silver which he had stolen from his own dining-room, and utensils which he had stolen from his own kitchen, and for which he had afterward bought substitutes with his own money.

*Constructiveness* is as genuine and irresistible an instinct in man as in the bee or the beaver. Whatever things are plastic to his hands, those things he must remodel into shapes of his own, and the result of the remodeling, however useless it may be, gives him more pleasure than the original thing. The mania of young children for breaking and pulling apart whatever is given them, is more often the expression of a rudimentary constructive impulse than of a destructive one. "Blocks" are the playthings of which they are least apt to tire. Clothes, weapons, tools, habitations, and works of art are the result of the discoveries to which the plastic instinct leads, each individual starting where his forerunners left off, and tradition preserving all that once is gained. Clothing, where not necessitated by cold, is noth-

* Cf. Flint, "Mind," vol. i, pp. 330–333; Sully, ibid., p. 567. Most people probably have the *impulse* to keep bits of useless finery, old tools, pieces of once useful apparatus, etc.; but it is normally either inhibited at the outset by reflection, or, if yielded to, the objects soon grow displeasing and are thrown away.

ing but a sort of attempt to remodel the human body itself—an attempt still better shown in the various tattooings, tooth-filings, scarings, and other mutilations that are practiced by savage tribes. As for habitation, there can be no doubt that the instinct to seek a sheltered nook, open only on one side, into which he may retire and be safe, is in man quite as specific as the instinct of birds to build a nest. It is not necessarily in the shape of a shelter from wet and cold that the need comes before him, but he feels less *exposed* and more at home when not altogether uninclosed, than when lying all abroad. Of course the utilitarian origin of this instinct is obvious. But to stick to bare facts at present and not to trace origins, we must admit that this instinct now exists, and probably always has existed, since man was man. Habits of the most complicated kind are reared upon it. But even in the midst of these habits we see the blind instinct cropping out ; as, for example, in the fact that we feign a shelter within a shelter, by backing up beds in rooms with their heads against the wall, and never lying in them the other way—just as dogs prefer to get under or upon some piece of furniture to sleep, instead of lying in the middle of the room. The first habitations were caves and leafy grottoes, bettered by the hands ; and we see children to-day, when playing in wild places, take the greatest delight in discovering and appropriating such retreats and "playing house" there.

*Play.*—The impulse to play in special ways is certainly instinctive. A boy can no more help running after another boy who runs provokingly near him, than a kitten can help running after a rolling ball. A child trying to get into its own hand some object which it sees another child pick up, and the latter trying to get away with the prize, are just as much slaves of an automatic prompting as are two chickens or fishes, of which one has taken a big morsel into its mouth and decamps with it, while the other darts after in pursuit. All simple active games are attempts to gain the excitement yielded by certain primitive instincts, through feigning that the occasions for their exercise are there. They involve imitation, hunting, fighting, rivalry, acquisitiveness, and construction, combined in various ways ; their special rules are habits, discovered by accident, selected by intelligence, and propagated by tradition ; but unless they were founded in automatic impulses, games would lose most of their zest. The sexes differ somewhat in their play-impulses. As Schneider says : "The little boy imitates soldiers, models clay into an oven, builds houses, makes a wagon out of chairs, rides on horseback upon a stick, drives nails with the hammer, harnesses his brethren and comrades together and plays the stage-driver, or lets himself be captured as a wild horse by some one else. The girl, on the contrary, plays with her doll, washes and dresses it, strokes it, clasps and kisses it, puts it to bed and tucks it in, sings it a cradle-song, or speaks with it as if it were a living being. . . . This fact that a sexual difference exists in the play-impulse, that a boy gets more pleasure from a horse and rider and a soldier than from a doll, while with the girl the opposite is the case, is proof that an hereditary connection exists between the perception of certain things (horse, doll, etc.), and the feeling of pleasure, as well as between this latter and the impulse to play." *

There is another sort of human play, into which higher æsthetic feelings enter. I refer to that love of festivities, ceremonies, ordeals, etc., which seems to be universal in our species. The lowest savages have their dances, more or less formally conducted. The various religions have their solemn rites and exercises, and civic power symbolizes its grandeur by processions and celebrations of divers sorts. We have our operas and parties and masquerades. An element common to all these ceremonial games, as they may be called, is the excitement of concerted action as one of an organized crowd. The same acts, performed with a crowd, seem to mean vastly more than when performed alone. A walk with the people on a holiday afternoon, an excursion to drink beer or coffee at a popular "resort," or an ordinary ball-room, are examples of this. Not only are we amused at seeing so many strangers, but there is a distinct stimulation at feeling our share in their collective life. The perception of them is the stimulus, and the reaction upon it is our tendency to join them and do what they are doing, and our unwillingness to be the first to leave off and go home alone. This seems a primitive element in our nature, as it is difficult to trace any association of ideas that could lead up to it; although, once granting it to exist, it is very easy to see what its uses to a tribe might be in facilitating prompt and vigorous collective action. The formation of armies, and the undertaking of military expeditions would be among its fruits. In the ceremonial games, it is but the impulsive starting-point. What particular things the crowd then shall do, depends for the most part on the initiative of individuals, fixed by imitation and habit, and continued by tradition. The co-operation of other æsthetic pleasures with games, ceremonial or other, has a great deal to do with the selection of such as shall become stereotyped and habitual. The peculiar form of excitement called by Professor Bain the emotion of *pursuit*, the pleasure of a *crescendo*, is the soul of many common games. The immense extent of the play-activities in human life is too obvious to be more than mentioned.†

*Curiosty.*—Already pretty low down among vertebrates we find that any object may excite attention, provided it be only *novel*, and

* "Der Menschliche Wille," p. 205.

† Professor Lazarus ("Die Reize des Spieles," Berlin, 1883, p. 44) denies that we have an *instinct* to play, and says the root of the matter is the *aversion to remain unoccupied*, which substitutes a sham occupation when no real one is ready. No doubt this is true; but why the particular forms of sham occupation? The *elements* of all bodily games and of ceremonial games are given by direct excito-motor stimulations—just as when puppies chase one another and swallows have a parliament.

that attention may be followed by approach and exploration by nostril, lips, or touch. Curiosity and fear form a couple of antagonistic emotions liable to be awakened by the same outward thing, and manifestly *both* useful to their possessor. The spectacle of their alternation is often amusing enough, as in the timid approaches and scared *wheelings* which sheep or cattle will make in the presence of some new object they are investigating. I have seen alligators in the water act in precisely the same way toward a man seated on the beach in front of them—gradually drawing near as long as he kept still, frantically careering back as soon as he made a movement. Inasmuch as new objects *may* always be advantageous, it is better that an animal should not *absolutely* fear them. But, inasmuch as they may also possibly be harmful, it is better that he should not be quite indifferent to them either, but on the whole remaining on the *qui vive*, ascertain as much about them, and what they may be likely to bring forth, as he can, before settling down to rest in their presence. Some such susceptibility for being excited and irritated by the mere novelty, as such, of any movable feature of the environment must form the instinctive basis of all human curiosity; though, of course, the superstructure absorbs contributions from so many other factors of the emotional life that the original root may be hard to find. With what is called scientific curiosity, and with metaphysical wonder, the practical instinctive root has probably nothing to do. The stimuli here are not objects, but ways of conceiving objects, and the emotions and actions they give rise to are to be classed, with many other æsthetic manifestations, sensitive and motor, as *incidental* features of our mental life. The philosophic brain responds to an inconsistency or a gap in its knowledge, just as the musical brain responds to a discord in what it hears. At certain ages the sensitiveness to particular gaps and the pleasure of resolving particular puzzles reach their maximum, and then it is that stores of knowledge are easiest and most naturally laid in. But these effects may have had nothing to do with the uses for which the brain was originally given; and it is probably only within a few centuries, since religious beliefs and economic applications of science have played a prominent part in the conflicts of one race with another, that they may have helped to "select" for survival a particular type of brain. I shall have to consider this matter of incidental and supernumerary faculties in another place.

*Sociability and Shyness.*—As a gregarious animal, man is excited both by the absence and by the presence of his kind. To be alone is one of the greatest of evils for him. Solitary confinement is by many regarded as a mode of torture too cruel and unnatural for civilized countries to adopt. To one long pent up on a desert island, the sight of a human footprint or a human form in the distance would be the most tumultuously exciting of experiences. In morbid states of mind, one of the commonest symptoms is the fear of being alone. This fear may be assuaged by the presence of a little child, or even of a baby. In a case of hydrophobia known to the writer, the patient insisted on keeping his room *crowded* with neighbors all the while, so intense was his fear of solitude. In a gregarious animal, the perception that he is alone excites him to vigorous activity. Mr. Galton thus describes the behavior of the South African cattle whom he had such good opportunities for observing: "Although the ox has little affection for, or interest in, his fellows, he can not endure even a momentary separation from his herd. If he be separated from it by stratagem or force, he exhibits every sign of mental agony; he strives with all his might to get back again, and when he succeeds he plunges into its middle to bathe his whole body with the comfort of closest companionship." *

Man is also excited by the presence of his kind. The *bizarre* actions of dogs meeting strange dogs are not altogether without a parallel in our own constitution. We can not meet strangers without a certain tension, or talk to them exactly as to our familiars. This is particularly the case if the stranger be an important personage. It may then happen that we not only shrink from meeting his eye, but actually can not collect our wits or do ourselves any sort of justice in his presence. "This odd state of mind," says Darwin,† "is chiefly recognized by the face reddening, by the eyes being averted or cast down, and by awkward, nervous movements of the body. . . . Shyness seems to depend on sensitiveness to the opinion, whether good or bad, of others, more especially with respect to external appearance. Strangers neither know nor care anything about our conduct or character, but they may, and often do, criticise our appearance. . . . The consciousness of anything peculiar, or even new, in the dress, or any slight blemish on the person, and more especially on the face—points which are likely to attract the attention of strangers—makes the shy intolerably shy.‡ On the other hand, in those cases in which conduct, and not personal appearance, is concerned, we are much more apt to be shy, in the presence of acquaintances whose judgment we in some degree value, than in that of strangers. . . . Some persons, however, are so sensitive, that the mere act of speaking to almost any one is sufficient to rouse their self-consciousness, and a slight blush is the result. Disapprobation . . . causes shyness and blushing much more readily than does approbation. . . . Persons who are exceedingly shy are rarely shy in the presence of those with whom they are quite familiar, and of whose good opinion and sympathy they are quite assured; for instance, a girl in presence of her mother. . . . Shyness . . . is closely related to fear; yet it is distinct from fear in the ordinary sense. A shy man

* "Inquiries into Human Faculty," p. 72.

† "Expression of the Emotions," New York, 1873, p. 330.

‡ "The certainty that we are well dressed," some lady has said, "gives us a peace of heart to which that yielded by the consolations of religion is as nothing."

dreads the notice of strangers, but can hardly be said to be afraid of them; he may be as bold as a hero in battle, and yet have no self-confidence about trifles in the presence of strangers. Almost every one is extremely nervous when first addressing a public assembly, and most men remain so through their lives." As Mr. Darwin observes, a real dread of definite consequences may enter into this "stage-fright" and complicate the shyness. Even so our shyness before an important personage may be complicated by what Professor Bain calls "servile terror," based on representation of definite dangers if we fail to please. But both stage-fright and servile terror may exist with the most indefinite apprehensions of danger, and, in fact, when our reason tells us there is no occasion for alarm. We must, therefore, admit a certain amount of purely instinctive perturbation and constraint, due to the consciousness that we have become objects for other people's eyes. Mr. Darwin goes on to say: "Shyness comes on at a very early age. In one of my own children, two years and three months old, I saw a trace of what certainly appeared to be shyness directed toward myself, after an absence from home of only a week." Every parent has noticed the same sort of thing. Considering the despotic powers of rulers in savage tribes, respect and awe must, from time immemorial, have been emotions excited by certain individuals; and stage-fright, servile terror, and shyness, must have had as copious opportunities for exercise as at the present time. Whether these impulses could ever have been useful, and selected for usefulness, is a question which, it would seem, can only be answered in the negative. Apparently they are pure hindrances, like fainting at sight of blood or disease, sea-sickness, a dizzy head on high places, and certain squeamishnesses of æsthetic taste. They are *incidental* emotions, in spite of which we get along. But they seem to play an important part in the production of two other propensities, about the instinctive character of which a good deal of controversy has prevailed. I refer to cleanliness and modesty, to which we must proceed, but not before we have said a word about another impulse closely allied to shyness. I mean—

*Secretiveness,* which, although often due to intelligent calculation and the dread of betraying our interests in some more or less definitely foreseen way, is quite as often a blind propensity, serving no useful purpose, and is so stubborn and ineradicable a part of the character as fully to deserve a place among the instincts. Its natural stimuli are unfamiliar human beings, especially those whom we respect. Its reactions are the arrest of whatever we are saying or doing when such strangers draw nigh, coupled often with the pretense that we were not saying or doing that thing, but possibly something different. Often there is added to this a disposition to mendacity when asked to give an account of ourselves. With many persons the first impulse, when the door-bell rings, or a visitor is suddenly announced, is to scuttle out of the room, so as not to be "caught." When a person at whom we have been looking becomes aware of us, our immediate impulse may be to look the other way, and pretend we have not seen him. Many friends have confessed to me that this is a frequent phenomenon with them in meeting acquaintances in the street, especially unfamiliar ones. The bow is a secondary correction of the primary feint that we do not see the other person. Probably most readers will recognize in themselves, at least, the *start*, the nascent disposition, on many occasions, to act in each and all of these several ways. That the "start" is neutralized by second thought proves it to come from a deeper region than thought. There is unquestionably a native impulse in every one to conceal love-affairs, and the acquired impulse to conceal pecuniary affairs seems in many to be almost equally strong. It is to be noted that even where a given habit of concealment is reflective and deliberate, its motive is far less often definite prudence than a vague aversion to have one's sanctity invaded and one's personal concerns fingered and turned over by other people. Thus, some persons will never leave anything with their name written on it, where others may pick it up—even in the woods, an old envelope must not be thrown on the ground. Many cut all the leaves of a book of which they may be reading a single chapter, so that no one shall know which one they have singled out, and all this with no *definite* notion of harm. The impulse to conceal is more apt to be provoked by superiors than by equals or inferiors. How differently do boys talk together when their parents are not by! Servants see more of their masters' characters than masters of servants'.* Where we conceal from our equals and familiars, there is probably always a definite element of prudential prevision involved. *Collective* secrecy, mystery, enters into the emotional interest of many games, and is one of the elements of the importance men attach to freemasonries of various sorts, being delightful apart from any end.

*Cleanliness.*—Seeing how very filthy savages and exceptional individuals among civilized people may be, philosophers have doubted whether any genuine instinct of cleanliness exists, and whether education and habit be not responsible for whatever amount of it is found. Were it an instinct, its stimulus would be dirt, and its characteristic reaction the shrinking from contact therewith, and the cleaning of it

* Thackeray, in his exquisite "Roundabout Paper," "On a Chalk-Mark on the Door," says: "You get truth habitually from equals only; so, my good Mr. Holyshade, don't talk to me about the habitual candor of the young Etonian of high birth, or I have my own opinion of *your* candor or discernment when you do. No. Tom Bowling is the soul of honor, and has been true to Black-eyed Syousan since the last time they parted at Wapping Old Stairs; but do you suppose Tom is perfectly frank, familiar, and above-board in his conversation with Admiral Nelson, K. C. B.? There are secrets, prevarications, fibs, if you will, between Tom and the admiral—between your crew (of servants) and *their* captain. I know I hire a worthy, clean, agreeable, and conscientious male or female hypocrite at so many guineas a year to do so and so for me. Were he other than hypocrite, I would send him about his business."

away after contact had occurred. Now, if some animals are cleanly, men *may* be so, and there can be no doubt that some kinds of matter *are* natively repugnant, both to sight, touch, and smell—excrementitious and putrid things, blood, pus, entrails, and diseased tissues, for example. It is true that the shrinking from contact with these things may be inhibited very easily, as by a medical education; and it is equally true that the impulse to clean them away may be inhibited by so slight an obstacle as the thought of the coldness of the ablution, or the necessity of getting up to perform it. It is also true that an impulse to cleanliness, habitually checked, will become obsolete fast enough. But none of these facts prove the impulse never to have been there.* It seems to be there in all cases; and then to be particularly amenable to outside influences, the child having his own degree of squeamishness about what he shall touch or eat, and later being either hardened or made more fastidious still by the habits he is forced to acquire and the examples among which he lives.

Examples get their hold on him in this way, that a particularly evil-smelling or catarrhal or lousy comrade is rather offensive to him, and that he sees the odiousness in another of an amount of dirt to which he would have no spontaneous objection if it were on his own skin. That *we dislike in others things which we tolerate in ourselves* is a law of our æsthetic nature about which there can be no doubt. But as soon as generalization and reflection step in, this judging of others leads to a new way of regarding ourselves. "Who taught you politeness? The impolite," is, I believe, a Chinese proverb. The concept, "dirty fellow," which we have formed, becomes one under which we personally shrink from being classed; and so we "wash up," and set ourselves right, at moments when our social self-consciousness is awakened, in a manner toward which no strictly instinctive native prompting exists. But the standard of cleanliness attained in this way is not likely to go beyond the mutual tolerance for one another of the members of the tribe, and hence may comport a good deal of actual filth.

*Modetsy, Shame.*—Whether there be an instinctive impulse to hide certain parts of the body and certain acts, is perhaps even more open to doubt than whether there be an instinct of cleanliness. Anthropologists have denied it, and in the utter shamelessness of infancy and of many savage tribes, have seemed to find a good basis for their views. It must, however, be remembered that infancy proves nothing, and that, as far as sexual modesty goes, the sexual impulse itself works directly against it at times of excitement, and with reference to certain people; and that habits of immodesty contracted with those people,

* The insane symptom called "mysophobia," or dread of foulness, which leads a patient to wash his hands perhaps a hundred times a day, hardly seems explicable without supposing a primitive impulse to clean one's self of which it is, as it were, the convulsive exaggeration.

may forever afterward inhibit any impulse to be modest toward *them.* This would account for a great deal of actual immodesty, even if an original modest impulse were there. On the other hand, the modest impulse, if it do exist, must be admitted to have a singularly ill-defined sphere of influence, both as regards the presences that call it forth, and as regards the acts to which it leads. Ethnology shows it to have very little backbone of its own, and to follow easily fashion and example. Still, it is hard to see the ubiquity of *some* sort of tribute to shame, however perverted—as where female modesty consists in covering the face alone, or immodesty in appearing before strangers unpainted—and to believe it to have no impulsive root whatever. Now, what may the impulsive root be? I believe that, for one thing, it is shyness, the feeling of dread that unfamiliar persons, as explained above, may inspire us withal. Such persons are the original stimuli to our modesty.* But the actions of modesty are quite different from the actions of shyness. They consist of the restraint of certain bodily functions, and of the covering of certain parts; and why do such particular actions necessarily ensue? That there *may* be in the human animal, as such, a "blind" and immediate automatic impulse to such restraints and coverings in respect-inspiring presences, is a possibility difficult of actual disproof. But it seems more likely, from the facts, that the actions of modesty are suggested to us in a roundabout way; and that, even more than those of cleanliness, they arise from the application in the second instance to ourselves of judgments primarily passed upon our mates. It is not easy to believe that, even among the nakedest savages, an unusual degree of cynicism and indecency in an individual should not beget a certain degree of contempt, and cheapen him in his neighbor's eyes. Human nature is sufficiently homogeneous for us to be sure that everywhere reserve must inspire some respect, and that persons who suffer every liberty are persons whom others disregard. "Not to be like such people," then, would be one of the first resolutions suggested by social self-consciousness to a child of nature just emerging from the unreflective state. And the resolution would probably acquire effective pungency for the first time when the social self-consciousness was sharpened into a real fit of shyness by some person being present whom it was important not to disgust or displease. Public opinion would of course go on to build its positive precepts upon this germ; and, through a variety of examples and experiences, the ritual of modesty would grow, until it reached the New England pitch of sensitiveness and range, making us say stomach instead of belly, limb instead of leg, retire instead of go to bed, and forbidding us to call a female dog by name.

* "We often find modesty coming in only in the presence of foreigners, especially of clothed Europeans. Only before these do the Indian women in Brazil cover themselves with their girdle, only before these do the women on Timor conceal their bosom. In Australia we find the same thing happening." (Th. Waitz, "Anthropologie der Naturvölker," vol. i, p. 358). The author gives bibliographical references, which I omit.

At bottom this amounts to the admission that, though in some shape or other a natural and inevitable feature of human life, modesty need not necessarily be an instinct in the pure and simple excito-motor sense of the term.

*Love.*—Of all propensities, the sexual impulses bear on their face the most obvious signs of being instinctive, in the sense of blind, automatic, and untaught. The teleology they contain is often at variance with the wishes of the individuals concerned; and the actions are performed for no assignable reason but because Nature urges just that way. Here, if ever, then, we ought to find those characters of fatality, infallibility, and uniformity, which, we are told, make of actions done from instinct a class so utterly apart. But is this so? The facts are just the reverse: the sexual instinct is particularly liable to be checked and modified by slight differences in the individual stimulus, by the inward condition of the agent himself, by habits once acquired, and by the antagonism of contrary impulses operating on the mind. One of these is the ordinary shyness recently described; another is what might be called the *anti-sexual instinct*, the instinct of personal isolation, the actual repulsiveness to us of the idea of intimate contact with most of the persons we meet, especially those of our own sex.* Thus it comes about that this strongest passion of all, so far from being the most "irresistible," may, on the contrary, be the hardest one to give rein to, and that individuals in whom the inhibiting influences are potent may pass through life and never find an occasion to have it gratified. There could be no better proof of the truth of that proposition with which we began our study of the instinctive life in man, that irregularity of behavior may come as well from the possession of too many instincts as from the lack of any at all.

The instinct of personal isolation, of which we have spoken, exists more strongly in men with respect to one another, and more strongly in women with respect to men. In women it is called coyness, and has to be positively overcome by a process of wooing before the sexual instinct inhibits it and takes its place. As Darwin has shown in his book on the "Descent of Man and Sexual Selection," it has played a vital part in the amelioration of all higher animal types, and is to a great degree responsible for whatever degree of chastity the human race may show. It illustrates strikingly, however, the law of the inhibition of instincts by habits—for, once broken through with a given person, it is not apt to assert itself again; and habitually broken through, as by prostitutes, with various persons, it may altogether decay. Habit also fixes it in us toward certain individuals: nothing is so particularly displeasing as the notion of close personal contact with those with whom we have long known in a respectful and distant way. The fondness of the ancients and of modern Orientals for forms

* To most of us it is even unpleasant to sit down in a chair still warm from occupancy by another person's body. To many hand-shaking is disagreeable.

of unnatural vice, of which the notion affects us with horror, is probably a mere case of the way in which this instinct may be inhibited by habit. We can hardly suppose that the ancients had by gift of Nature a propensity of which we are devoid, and were all victims of what is now a pathological aberration limited to individuals. It is more probable that with them the anti-sexual impulse toward a certain class of objects was inhibited early in life by *habits* formed under the influence of *example;* and that then a kind of sexual appetite, of which very likely most men possess the germinal possibility, developed itself in an unrestricted way. That the development of it in an abnormal way may check its development in the normal way, seems to be a well-ascertained medical fact. And that the direction of the sexual instinct toward one individual tends to inhibit its application to other individuals, is a law, upon which, though it suffers many exceptions, the whole *régime* of monogamy is based. These details are a little unpleasant to discuss, but they show so beautifully the correctness of the general principles in the light of which our review has been made, that it was impossible to pass them over unremarked.

*Jealousy* is unquestionably instinctive.

*Parental Love* is an instinct stronger in woman than in man, at least in the early childhood of its object. I need do little more than quote Schneider's lively description of it as it exists in her:

"As soon as a wife becomes a mother her whole thought and feeling, her whole being, is altered. Until then she had only thought of her own well-being, of the satisfaction of her vanity; the whole world appeared made only for her; everything that went on about her was only noticed so far as it had personal reference to herself; she asked of every one that he should appear interested in her, pay her the requisite attention, and as far as possible fulfill her wishes. Now, however, the center of the world is no longer herself, but her child. She does not think of her own hunger, she must first be sure that the child is fed. It is nothing to her that she herself is tired and needs rest, so long as she sees that the child's sleep is disturbed; the moment it stirs she awakes, though far stronger noises fail to arouse her now. She, who formerly could not bear the slightest carelessness of dress, and touched everything with gloves, allows herself to be soiled by the infant, and does not shrink from seizing its clouts with her naked hands. Now, she has the greatest patience with the ugly, piping cry-baby" (*Schreihals*), "whereas until now every discordant sound, every slightly unpleasant noise, made her nervous. Every limb of the still hideous little being appears to her beautiful, every movement fills her with delight. She has, in one word, transferred her entire egoism to the child, and lives only in it. Thus, at least, it is in all unspoiled, naturally-bred mothers, who, alas! seem to be growing rarer; and thus it is with all the higher animal-mothers. The maternal joys of a cat, for example, are not to be disguised. With an expression of infinite comfort she stretches out her fore-legs to offer her teats to her children, and moves her tail with delight when the little hungry mouths tug and suck. . . .

"But not merely the contact, the mere look of the offspring affords endless delight, not only because the mother thinks that the child will some day grow great and handsome and bring her many joys, but because she has received from Nature an instinctive love for her children. She does not herself know why she is so happy, and why the look of the child and the care of it are so agreeable, any more than the young man can give an account of why he loves a maiden, and is so happy when she is near. Few mothers, in caring for their child, think of the proper purpose of maternal love for the preservation of the species. Such a thought may arise in the father's mind; seldom in that of the mother. The latter feels only . . . that it is an everlasting delight to hold the being which she has brought forth protectingly in her arms, to dress it, to wash it, to rock it to sleep, or to still its hunger."

So far the worthy Schneider, to whose words may be added this remark, that the passionate devotion of a mother—ill herself, perhaps—to a sick or dying child, is perhaps the most simply beautiful moral spectacle that human life affords. Contemning every danger, triumphing over every difficulty, outlasting all fatigue, woman's love is here invincibly superior to anything that man can show.

These are the most prominent of the tendencies which are worthy of being called instinctive in the human species.* It will be observed that no other mammal, not even the monkey, shows so large an array. In a perfectly-rounded development, every one of these instincts would

* Some will, of course, find the list too large, others too small. With the boundaries of instinct fading off into reflex action below, and acquired habit or suggested activity above, it is likely that there will always be controversy about just what to include under the class-name. Shall we add the propensity to walk along a curbstone, or any other narrow path, to the list of instincts? Shall we subtract secretiveness, as due to shyness or to fear? Who knows? Meanwhile our physiological method has this inestimable advantage, that such questions of limit have neither theoretical nor practical importance. The facts once noted, it matters little how they are named. Most authors give a shorter list than that in the text. The phrenologists add adhesiveness, inhabitiveness, love of approbation, etc., etc., to their list of "sentiments," which in the main agree with our list of instincts. Fortlage, in his "System der Psychologie," classes among the *Triebe* all the vegetative physiological functions. Santlus ("Zur Psychologie der Menschlichen Triebe," Leipsic, 1864) says there are at bottom but three instincts, that of "Being," that of "Function," and that of "Life." The "Instinct of Being" he subdivides into *animal*, embracing the activities of all the senses; and *psychical*, embracing the acts of the intellect and of the "transempiric consciousness." The "Instinct of Function" he divides into *sexual*, *inclinational* (friendship, attachment, honor); and *moral* (religion, philanthropy, faith, truth, moral freedom, etc.). The "Instinct of Life" embraces *conservation* (nutrition, motion); *sociability* (imitation, juridical and ethical arrangements); and *personal interest* (love of independence and freedom, acquisitiveness, self-defense). Such a muddled list as this shows how great are the advantages of the physiological analysis we have used.

start a habit toward certain objects and inhibit a habit toward certain others. Usually this is the case; but, in the one-sided development of civilized life, it happens that the timely age goes by in a sort of starvation of objects, and the individual then grows up with gaps in his psychic constitution which future experiences can never fill. Compare the accomplished gentleman with the poor artisan or tradesman of a city: during the adolescence of the former, objects appropriate to his growing interests, bodily and mental, were offered as fast as the interests awoke, and, as a consequence, he is armed and equipped at every angle to meet the world. Sport came to the rescue and completed his education where real things were lacking. He has tasted of the essence of every side of human life, being sailor, hunter, athlete, scholar, fighter, talker, dandy, man of affairs, etc., all in one. Over the city poor boy's youth no such golden opportunities were hung, and in his manhood no desires for most of them exist. Fortunate it is for him if gaps are the only anomalies his instinctive life presents; perversions are too often the fruit of his unnatural bringing up.

# PHYSIOLOGY OF FREEZING.

By Dr. von NUSSBAUM.

SERIOUS ills often result from exposure to freezing, merely because many people do not know how to guard against troubles so induced. Delicate white faces are sometimes disfigured by the nose turning red; this is liable to happen to one who has suffered from freezing of the organ, usually at the first snow-fall, perhaps even in midsummer; the hands may display, at these times, bluish-red and swollen fingers, and all this only because at some time in early youth, when these members had become frozen, proper care was not taken of them, and because there was nobody at hand who could offer sound advice. Chilblains, when wrongly treated, become very troublesome, and may lead to the loss of fingers or toes by mortification; and such an occurrence can even endanger life. If, during intense cold, we are subjected to influences that tend to lower our vitality, we may fall into a sleep, from which perhaps we may never awake.

No man knows in what circumstances he may at some time be placed. The courageous soldiers who, with Napoleon I, left the burning city of Moscow, probably never dreamed, while in sunny France, that they would sink down on snow-banks, and fall into a sleep that ends but in death! Many of them could perhaps have saved their lives if they had ever heard of the proper precautions to be taken against this danger. Some persons think that the drinking of strong liquor will enable them to resist the cold more readily; this, however, is very delusive. Even if we increase the activity of some organs by a stimulating drink, we must not forget that the taking of liquor causes the blood to rush to the brain, and that the cold, too, drives the blood from the skin to the inner organs, and particularly to the brain. Strong drink must, therefore, favor the congestion of the brain which is caused by cold.

Good nourishment, an energetic character, and a sound heart, are the best preventives against the danger of perishing by cold. Close-fitting garments, which impede the circulation of the blood, and exposure in damp, windy weather should, if possible, be carefully avoided.

Many persons have the idea that life is endangered *only*, if the patient be brought too suddenly from the cold into a warm place. They believe that, if one proceed very carefully and slowly with the warming, the cold can never produce a lasting injury to the system. There is certainly no doubt that sudden warming is very dangerous, and that a great deal depends upon the right treatment of the frozen limb. Experience shows that, while some people have frozen joints treated in such a manner that they are completely restored, others are less fortunate, and suffer frequently in after-years. But one must admit that intense cold alone, without being followed by sudden warming, which proves so disastrous, suffices to cause severe suffering. In this respect, a great deal depends on the nature of the person. If very sudden transitions from heat to cold and from cold to heat be avoided, a healthy person can withstand intense cold without serious consequences, especially if he be mentally active, energetic, and muscular, and has a sound heart—that is, if his pulse be regular and strong. A robust person can withstand the temperature at which alcohol and mercury freeze. Members of north-pole expeditions have experienced temperatures of fifty or more degrees below zero without suffering harm.

However, it happens not unfrequently that even moderately cold weather, when the thermometer is but a few degrees below the freezing-point, causes serious ills, and sometimes even fatal results. This is apt to happen to persons who are anæmic, poorly fed, effeminate, or mentally depressed. Old men, children, anæmic girls, drunkards, and people with a weak heart, are all liable to be frost-bitten, and easily freeze to death if they succumb to sleep while exposed to intense cold. They fall into a sort of stupor, sit down to rest, soon fall asleep, and in most instances never awake. For a long time they remain in a condition bordering on death ; they breathe a little, and the heart makes feeble attempts to maintain the circulation of the blood.

This beating of the heart is the cause of the long duration of this death-like trance. The heart exerts a slight pressure on the lungs, and causes thereby a sort of artificial breathing, which, however, is so slight that laymen and even physicians often erroneously consider people who are merely frozen to be dead.

When Napoleon I had returned to France from Russia, he felt convinced that many of his soldiers had been buried alive, and he offered a large reward for the surest means of distinguishing between this trance-like condition and actual death. The prize was awarded to Professor Andral, who claimed that listening to the heart-sounds by means of the stethoscope was the surest way of ascertaining whether death had taken place or not, because with this instrument could still be heard the movement of the heart-valves, when by all other tests one could no longer detect any sign of life. Napoleon's prize might, however, well have been awarded to Professor Middeldorf, of Breslau, who with his *akidopeirastic* (needle-test) was able to detect signs of life some time after the sound caused by the movement of the heart-valves had ceased to be audible with Andral's stethoscope.

Up to the present day this method is the most reliable one for ascertaining whether death has occurred or not. It is surer than the cutting of the sole, the burning with sealing-wax, or any other test. A long needle is thrust (between the fifth and sixth ribs) into the heart, a proceeding that is not at all dangerous, provided that the needle does not enter below a certain depth. The needle must be of such length that about one half of it projects from the chest; the slightest movement of the heart will cause that part of the needle which is visible to vibrate.

But no one need fear that those soldiers of Napoleon who were thus buried alive ever awakened in their graves. As surely as there can be no question but that by careful treatment quite a number of them could have been saved, just as confidently can it be asserted that their numbness, provided no careful attempts were made to restore them to life, resulted in actual death. Unfortunately, it has not yet been ascertained how long this trance-like condition may last with the frozen—whether five or six days (many such cases are known), or whether it may not continue even longer.

We have already, at the beginning, referred to the danger of an incautious warming of the frozen. If the warming be accomplished too quickly, a sudden reaction will set in, which the patient will not be able to survive. Blood which has been frozen and then thawed is still red, but of a different shade. The coloring matter of the blood has become separated from the blood-cells. Blood of this description causes congelation in blood which is in its normal state. One can kill an animal in sound health by injecting such blood into its veins. But the process takes a different turn in cases where the frozen are *gradually* warmed and restored. If a very minute quantity of the frozen blood is again brought into solution and sent into the system, this small amount of poison will be taken care of. This is the reason why, in all attempts at revivifying persons who have been frozen, the warming and the restoring of the juices to their normal condition must be gradually done. The best way is to lay the patient into snow, to rub him with snow (which should be renewed several times), and then to follow this treatment up with very cold water. Then give a cold bath in an unheated room, rub the chest and the region of the heart thoroughly with fresh water, and finally put the patient into a cold bed, cover him with cold cloths, and give an enema of cold water.

Some blow fresh air into one of the nostrils by means of bellows, while the other nostril and the mouth are kept firmly closed. But, as far as my experience goes, by this treatment the air is much more likely to get into the stomach than into the lungs. If it is necessary to induce artificial respiration, it is better to alternately press the arms of the patient firmly to his chest and then to raise them above his body, or, what is even more simple, squeeze together every two or three seconds both chest and abdomen with the hands.

As soon as faint signs of life, such as a twitching of the eyes, a change in the color of the lips, or an attempt at breathing are noticed, the nose should be tickled with a feather, and a few drops of some stimulating fluid, either wine, brandy, or ammonia, should be poured into the mouth and throat. When the symptoms of returning life become more marked, pour a few teaspoonfuls of one of the above-mentioned liquids into the mouth and give an injection with a spoonful of wine or brandy, and also use one of the liquids to rub the skin ; then put the patient into a warm bed. After this, some warm soup or a cup of coffee will be in place. Should the excitement become too great, it is advisable to give a lukewarm bath and some soothing potion.

In the every-day happenings of our life such accidents occur but rarely. However, complaints of frozen fingers, toes, ears, and noses, and chilblains, are frequent.

Many people think that fingers, toes, and noses are apt to be frozen because they are so distant from the heart, and are in consequence not so plentifully supplied with warm blood. Although I do not wish to dispute this entirely, the main reason seems to be that these parts are very thin and small and come more directly in contact with the air. When such small parts are exposed to intense cold, the veins contract and drive the blood toward the interior. The backs of the fingers and toes freeze first ; they become pale and devoid of feeling, and the joints benumbed and stiff. After a while the blood in the veins congeals, all tissues grow brittle and break easily. But frozen joints are not dead. If gradually warmed they can be restored entirely ; if, however, they have been exposed to intense cold and are then suddenly warmed, a strong inflammatory reaction sets in, the same as when normally warm parts are exposed to a temperature as high as that of boiling water. Cold alone can produce numbness and insensibility ; but an inflammatory reaction is alone due to too rapid a warming. To such careless treatment only must the troubles which are known as frozen joints, chilblains, etc., be ascribed. Chilblains, where the skin and tissues are inflamed, cause a disagreeable itching in warm weather.

The first stage of such an inflammation makes the joints appear bluish-red, violet, and swollen. Frozen joints are at the beginning cold and difficult to move; they cause a stinging pain, particularly in the evening during damp, cold weather. During spring and summer the trouble often disappears entirely, but sometimes it appears even in midsummer. During the first winter the pains are more severe than in the following years.

A *second* and more advanced stage of localized freezing takes place where the cold was more intense, or where the organs were subjected to a more sudden warming. All symptoms are then more severe; the skin of the fingers cracks, and painful cuts, blisters, and sores result.

As the *third* stage of freezing, those instances are denoted where the frozen joints become immediately mortified, or where they are at first greatly inflamed and then become mortified. The mortification, however, rarely penetrates deeply; it is mostly restricted to the outer skin, which turns gray, black, and dry. Beneath this superficial mortification there is generally found an ulcer that can be cured.

When a frozen joint grows warm, and the congealed blood again becomes liquid, the blood can enter for a time into the open vessels; then the question arises if the blood-vessels and the tissues can perform the necessary transformation, or whether, as we have already suggested, the blood which had been frozen will act as a poison, induce the normal blood to congeal, and interrupt its circulation. This will then give rise to an insufficient supply, and will even induce dangerous poisoning. This is no doubt the main reason why the sudden warming of frozen individuals or frozen joints proves to be so dangerous.

The best advice, and the counsel to be given, above all, is, guard against freezing! In looking over what has been said so far, the best safeguard against this danger proves to be a strong, healthy, well-nourished body and a sound heart. Furthermore, for very cold weather, warm, common-sense clothing, which does not fit closely, and hence does not impede the circulation of the blood, is to be recommended.

Dresses of woolen goods are naturally warmer than those of linen or silk, the latter being better conductors of heat. During intensely cold weather, particularly when a dry wind is blowing, woolen gloves will not be amiss.

A certain robustness of health should be acquired by every one, and effeminacy of any kind should be avoided. Healthy children should go out in any kind of weather, and they should be rendered more hardy by cold washings daily. On wet days, if garments and shoes become damp, they should be replaced by dry ones immediately on returning home.

But if one has actually met with the misfortune of having a joint frozen, so that it is white, stiff, cold, and devoid of feeling or power of motion, the principal advice, not to be forgotten, is, not to warm the frozen part too quickly; rub the joint in a cold room with snow or ice until some sensibility returns; then rub it with cold water, and wrap it up in fine linen rags, which should be moistened with a mixture of five parts of Goulard's solution and one part of spirits of camphor, and then tie it up in a rubber sheeting or oiled silk. Quite useful, too, will prove, after some feeling has returned, a hand or a foot bath with bleaching-powder. For this purpose a tablespoonful of bleaching-powder is dissolved in a basin of cold water. In order to be sure of doing everything that can be done, on going to bed at night, wrap up the frozen joints in flannel, and drink something that will cause perspiration.

If a hand or foot, even though it may have been entirely frozen, be rubbed with snow until the return of feeling, and is then at night brought into perspiration, the injury will in most cases have been entirely cured, and no relapse need be feared.

The few directions that have here been given will, if carefully followed, suffice. Of course, there are legions of cures and curatives that are recommended for frozen joints. These, however, are in place only where, through careless treatment, after-effects of the freezing, such as ulcers, chilblains, etc., remain. The frequent occurrence of such ills proves how rarely a frozen joint has received the right attention in the first place, when it would have been entirely restored.

There are some physicians who believe it impossible to prevent chilblains when a joint has once been frozen. It is, of course, true that severe cases of freezing will occur where even the best of care is powerless to prevent serious trouble, and which may sometimes even involve the loss of some part of the frozen joint.

All things considered, however, it may be said that one can guard against permanent injuries through frost if the right treatment be adopted immediately after the freezing has occurred; and even that those injuries which have been caused by too rapid a warming and other wrong treatment can be materially improved by attentive and correct care.

For the removal of those red spots which appear principally on the nose, and which may prove quite disfiguring, we used to employ hot-water vapors, followed by washings with a solution of dilute hydrochloric acid (one to six), or a solution of bleaching-powder in water. Lately, however, I advise, and with better results, the application of hot-water vapors, and at night the putting on of a salve made up of one part of ichthyol and eight parts of vaseline.

Unfortunately, the ichthyol has a brown color, but this can easily be removed in the morning by using warm water and soap. If any one is particularly sensitive respecting his appearance, he may repeat the treatment with the ichthyol in the morning, after having employed the water-vapor, thus using the remedy twice in twenty-four hours, which will materially hasten the desired effect.

Among the large number of things that have been recommended, each one has its peculiarities; some natures derive more benefit from the one; others, again, from another, a fact which makes it advisable to leave the choice of the agent to be used to some physician who is acquainted with the constitution of the patient; for all agents which are powerful and useful may cause great injury if indiscreetly applied. —*Translated for the Popular Science Monthly from Die Gartenlaube.*

## SKETCH OF J. J. AUDUBON.

WHEN Audubon's fame was just beginning, "Christopher North" (Professor Wilson, of the University of Edinburgh, and editor of "Blackwood's Magazine") wrote, under the form of a dialogue between himself and the Ettrick Shepherd (James Hogg, the poet), as follows: *

"*North.* What a pity, James, that you were not in Edinburgh in time to see my friend Audubon's exhibition!

"*Shepherd.* An exhibition o' what?

"*North.* Of birds painted to the life. Almost the whole American ornithology, true to nature as if the creatures were in their native haunts in the forests, or on the sea-shores. Not stiff and staring like stuffed specimens, but in every imaginable characteristic attitude, perched, wading, or a-wing—not a feather, smooth or ruffled, out of its place—every song, chirp, chatter, or cry made audible by the power of genius.

"*Shepherd.* Where got he sae weel acquaint wi' a' the tribes—for do they not herd in swamps and woods where man's foot intrudes not—and the wilderness is guarded by the rattlesnake, fearsome watchman, wi' nae ither bouets than his ain fiery eyne?

"*North.* For upward of twenty years the enthusiastic Audubon lived in the remotest woods, journeying to and fro on foot thousands of miles—or sailing on great rivers, great as any seas—with his unerring rifle, slaughtering only to embalm his prey by an art of his own, in form and hue unchanged, unchangeable—and now, for the sum of one shilling, may anybody that chooses it behold the images of all the splendid and gorgeous birds of that continent.

"*Shepherd.* Where's the exhibition now?

"*North.* At Glasgow, I believe—where I have no doubt it will attract thousands of delighted spectators. I must get the friend who gave a glance over 'Selby's Ornithology' to tell the world at large

* "Noctes Ambrosianæ" ("Blackwood's Magazine"), No. XXX, January, 1827.

more of Audubon. He is the greatest artist in his own walk that ever lived, and can not fail to reap the reward of his genius and perseverance and adventurous zeal in his own beautiful branch of natural history, both in fame and fortune."

John James Audubon was born near New Orleans, May 4, 1780, and died at the present Audubon Park, New York city, January 27, 1851. His father, the son of a fisherman of La Vendée, was a French naval officer, who, having become wealthy, had acquired a plantation in Louisiana, and married a lady of that colony, of Spanish descent. The son imbibed a love of Nature at an extremely early age, which was probably strengthened by his short residence on his father's plantation in Santo Domingo, and was not repressed, but mastered the situation when he was sent to France to be educated. It is recorded of him that he was accustomed to amuse himself when a mere child by trying to draw the birds he saw around him; and that, his crude efforts not being satisfactory, he used to make a bonfire of them at each birthday. His father desired him to be qualified for some occupation connected with the navy, or with engineering. He was sent to France, where the father had bought an estate near Nantes, on which his step-mother was living, to be taught mathematics, drawing, geography, fencing, and music. His drawing-master was the celebrated artist David, who set him to drawing "horses' heads and the limbs of giants," but he preferred birds, and improved such opportunities as he could get to exercise himself upon them, and spent much of his time in excursions into the woods, collecting specimens, and making drawings of them. The real supervision of his operations was with his indulgent step-mother, who gave him ample scope for the exercise of his own tastes. When Audubon's father returned from sea he was astonished at the large collection his son had made, and then asked what progress he had made in his other studies. The reply not being satisfactory, he took the youth in hand himself, and kept him for a year in the close study of mathematics. But every opportunity for natural history rambles was still improved. Audubon spent another year at Nantes, when he went over after having returned to America, and settled at Mill Grove, to expose the unfaithfulness of an agent whom his father had intrusted with the charge of one of his enterprises, and to consult his parents respecting marriage. During one of these residences in Nantes he is credited with having made a hundred drawings of European birds. Three specimens of these works have recently come into the hands of Dr. R. W. Shufeldt, who has described them in "The Auk." They are all drawn in a combination of crayon and water-colors, on a thin and not expensive kind of drawing-paper; are numbered 44, 77, and 96, and represent the magpie, the coot, and the green woodpecker. The earliest of the sketches is the magpie, represented as of life-size and standing on the ground. "The execution is quite crude, though the naturalist 'sticks out' in it, for, notwithstanding the somewhat awkward position the bird is in, there is life in it." The second picture, that of a coot, "is a marked improvement on the magpie. Far more pains have been taken with the feet, legs, bill, and eye, though little has been gained in the natural attitude of the bird. . . . Except very faintly in the wing, no attempt has been made to individualize the feathers, the entire body being of a dead black, worked in either by burned cork or crayon." Dr. Shufeldt also remarks that, "as is usually the case among juvenile artists, both this bird and the magpie are represented upon direct lateral view, and no evidence has yet appeared to hint to us of the wonderful power Audubon eventually came to possess in figuring his birds in their every attitude." The green woodpecker "is a wonderful improvement, in every particular, upon both of the others. The details of the plumage and other structures are brought out with great delicacy, and refinement of touch; while the attitude of the bird, an old male, is even better than many of those published in his famous work. The colors are soft, and have been so handled as to lend to the plumage a very flossy and natural appearance, while the old trunk, upon the side of which the bird is represented, presents several evidences of an increase of the power to paint such objects."

When about seventeen or eighteen years old, young Audubon returned to the United States, and his father, willing to gratify his now decided tastes, settled him upon a farm which he owned near Philadelphia, "Mill Grove," at the mouth of Perkiomen Creek. Here he had full opportunity for the gratification of his huntsman's and naturalist's inclination, and improved it so industriously that he appeared to be good for little else. Desiring to form a matrimonial engagement with Lucy Bakewell, he was advised by the father of the young lady to go into business, and he accordingly entered the employment of a firm in New York; but even here it was the study of Nature and not trade that engaged his attention. "For a period of twenty years," he confesses in the biographical preface to his "Birds," "my life was a series of vicissitudes. I tried various branches of commerce, but they all proved unprofitable, doubtless because my whole mind was ever filled with my passion for rambling and admiring those objects of Nature from which alone I received the purest gratification." It is in connection with the relation of the story of a hurricane, while he was living at Henderson, years after his Philadelphia experiences, that he says that, just before the breaking out of the awful storm, his thoughts were, "for once, at least, in the course of my life, entirely engaged in commercial speculations." He soon gave up his New York engagement, and shortly afterward formed a partnership with Ferdinand Rosier to go into trade at Louisville, Kentucky. His settlement at this place having been determined upon, he was married to Miss Bakewell in April, 1808. This lady was a descendant of the Peverils of the Peak, one of whom has given name to one of Walter Scott's novels, and was a relative of the famous British geologist Bakewell. She proved a congenial wife to the naturalist, and gave him valuable aid while he had his great work under way, by helping him to pay the expenses of his enterprise out of the fruits of her own industry. The farm at Mill Grove was sold, a stock of goods was purchased with the proceeds, and Audubon removed with his wife to Louisville, making the journey down the Ohio River in a flat-boat, with two rowers. At Louisville, again, he left business to his partner, and occupied himself with natural history and his drawings.

In 1810 he was visited at his store by Alexander Wilson, who came to solicit subscriptions to his "Ornithology." He was about to sign the list, when his partner suggested to him, in French, that he could make better drawings than Wilson, and probably knew as much about American birds as he. Wilson understood the remark, and asked Audubon if he had any drawings of birds. Audubon exhibited what he had, and, to Wilson's question if he intended to publish his work, replied that he had never thought of it. The two naturalists seem to have spent some time together. Audubon explored the woods with Wilson, lent him his drawings, and aided him in various ways; but, after all this, Wilson, in the mortification of his vanity that he had met a superior in his own special field, had it in his heart to enter in his notes against Louisville that "science or literature had not one friend in the place."

As might be expected, the business at Louisville was not prosperous. After four years, marked by two removals to secure better success, the partnership was dissolved, and Audubon removed to Henderson, Kentucky, in 1812. Another business adventure, entered into with his brother-in-law in New Orleans, failed. Only natural history prospered with him. A very large proportion of his work in this line, which bore so noble and so abundant fruit in later years, was done during his residence in Henderson. Aiming to represent the birds which he drew in position as far as possible, he adopted ingenious devices to secure correct views of them as they looked in Nature. Those which he had to shoot he would afterward set up and support in natural attitudes, while he painted them; others he would view, with their actual surroundings, through a telescope. Audubon's father died about 1812, leaving to him the estate in France and seventeen thousand dollars, which had been deposited with a merchant in Richmond, Virginia. "Audubon, however, took no steps to obtain possession of his estate in France, and in after-years, when his sons had grown up, sent one of them to France for the purpose of legally transferring the property to his own sister Rosa." Before Audubon was able to obtain the money from the merchant in Richmond, the latter died insolvent; and so no benefit accrued to the naturalist from either part of his legacy.

By the pressure of this disappointment and other failures, Audubon was compelled to work for a living. He took up the drawing of crayon-portraits with much success, and is said to have seemed to get a new start in life. In a short time he received an invitation to become a curator of the museum at Cincinnati, and for the preparation of birds received a liberal remuneration. In conjunction with this situation he opened a drawing-school in the same city, and obtained from this employment additional emolument sufficient to support his family comfortably. His teaching succeeded well until several of his pupils started on their own account. The work at the museum having been finished, Audubon fell back upon his portrait-painting and such resources as his genius could command. Applying for assistance to an old friend whom he had helped into business, the ungrateful wretch declared he would do nothing for his benefactor, and further added that he would not even recommend one who had such wandering habits. On more occasions than this his genius for discovery was made an argument against him.

In October, 1820, Audubon left Cincinnati, and sailed down the Ohio in company with Captain Cumming, an engineer, who had been appointed to make a survey of the Mississippi River. He was provided with letters of introduction from General Harrison and Henry Clay, and intended a long ornithological excursion through Mississippi, Alabama, and Florida, up Red River, and down the Arkansas. At Bayou Sara, in the following June, he accepted an engagement with Mrs. Perrie to teach her daughter drawing during the summer months at sixty dollars a month. Mrs. Perrie's real aim is supposed to have been to provide for Audubon an opportunity to carry on his pursuits under the guise of an employment which would be congenial and not interfere with his work. Later in the year he was invited to join another artist in painting a panorama of New Orleans. But, he wrote in his journal, "My birds, my beloved birds of America, occupy all my time, and nearly all my thoughts, and I do not wish to see any other perspective than the last specimen of those drawings."

For the first two months of 1822 it is written by his wife in her "Life," "the records of Audubon's life are sparse and imperfect, on account of his inability to purchase a book to write his journal in!" The one at last obtained was made of thin, poor paper, and the records entered are rather in keeping with his financial difficulties. It took all his means at this time to supply his family with the necessaries of life; and in order to obtain money to educate the children, his wife undertook the duties of a situation in which she had charge of and educated the offspring of a Mr. Brand. They afterward removed to Natchez, where Audubon drew and taught drawing in the college at Washington, Mississippi, and Mrs. Audubon taught; and then to Bayou Sara, Louisiana, where Mrs. Audubon established a school, with the proceeds of which she was enabled to aid materially in the publication of the "Birds," and Audubon assisted her by teaching music and dancing. A member of one of the families, in which Mrs. Audubon was a governess during this period, has furnished Dr. Shufeldt with a childhood's reminiscence of the naturalist. "He was with us," she says, "eight months, but during the greater part of the time was wandering all over the State, walking almost the entire time; no insect, worm, reptile, bird, or animal escaped his notice. He would make a collection, return home and draw his crayon-sketches, when his son John would stuff the birds and such animals as he wished to preserve."

In the spring of 1824, Audubon, with two hundred drawings, representing about a thousand birds, went to Philadelphia in order obtain help to complete his ornithological work. He was soon satisfied, it is said in Mrs. Audubon's "Life," that the venture would be successful. Having purchased a new suit of clothes and dressed himself with extreme neatness, he called upon Dr. Mease, an old friend, and was introduced by him to several artists, who paid him pleasant attentions. He was also introduced to Prince Canino, son of Lucien Bonaparte, "who examined my birds," Audubon writes, "and was complimentary in his praises. He was at the time engaged on a volume of American birds, which was soon to be published; but this did not prevent him from admiring another naturalist's work.—*April 12th.* Met the prince at Dr. Mease's, and he expressed a wish to examine my drawings more particularly. I found him very gentlemanly. He called in his carriage and took me to Peale, the artist, who was drawing specimens of birds for his work; but from want of knowledge of the habits of birds in a wild state, he represented them as if seated for a portrait, instead of their own lively, animated ways when seeking their natural food or pleasure. Other notable persons called to see my drawings, and encouraged me with their remarks. The Prince Canino introduced me to the Academy of Arts and Sciences, and pronounced my birds superb and worthy of a pupil of David. I formed the acquaintance of Le Sueur, the zoölogist and artist, who was greatly delighted with my drawings." Audubon was engaged by Prince Canino to superintend his drawings intended for publication; but his terms being much dearer than Alexander Wilson's, he was asked to discontinue his work. "I had now," he writes, "determined to go to Europe with my 'treasures,' since I was assured nothing so fine in the way of ornithological representations existed. I worked incessantly to complete my series of drawings. On inquiry, I found Sully and Le Sueur made a poor living by their brush. I had some pupils offered at a dollar per lesson; but I found the citizens unwilling to pay for art, although they affected to patronize it. I exhibited my drawings for a week, but found the show did not pay, and so determined to remove myself."

Thus, notwithstanding the pleasant social aspect of his reception in Philadelphia, he does not appear to have been encouraged in its material promise; and he met with a misfortune which would have depressed the spirits of the bravest and most sanguine. His plates, the fruit of years of labor and of almost exclusive preoccupation during the whole time, were destroyed in a single night by rats. He went to work at once, however, to restore his drawings, and did so. Mr. McMurtrie, the conchologist, advised him to take his drawings to England. Prince Canino advised him to go to France. He proceeded to New York, having left Philadelphia "free from debt and free from anxiety about the future." In New York he visited the museum and "found the specimens of stuffed birds set up in unnatural and constrained attitudes. This appears to be the universal practice, and the world owes to me the adoption of the plan of drawings from animated nature. Wilson is the only one who has in any tolerable degree adopted my plan."

The prospect for having his drawings published in New York did not appear very encouraging, although it seemed more hopeful than it had been in Philadelphia. He visited the Lyceum, and his portfolio was examined by the members of the Institute, among whom, he writes, "I felt awkward and uncomfortable." After living among such people I felt clouded and depressed ; remember that I have done nothing, and fear that I may die unknown. I feel I am strange to all but the birds of America. In a few days I shall be in the woods and quite forgotten." On the next day : "My spirits low, and I long for the woods again ; but the prospect of becoming known prompts me to remain another day." He was invited by the artist, Vanderlyn, to sit for a portrait of General Jackson, whom his figure was thought to resemble considerably.

From New York he proceeded up the Hudson and into the lake-region, visiting Niagara, but not crossing over to Goat Island on account of the low state of his finances ; then returned by way of Erie, Pittsburg, and the rivers, to his home in Bayou Sara. His wife was receiving an income of nearly three thousand dollars a year from her labors in teaching, and he took charge of a class in dancing by which he cleared two thousand dollars ; and with this capital and his wife's savings he was now able to foresee a successful issue to his great ornithological work.

He had determined upon going to England where, although he knew no one, he hoped that he might find a way to get his plates engraved. He sailed from New Orleans in May, 1826, and arrived in Liverpool on the 20th of July. He exhibited his pictures, with satisfaction to his visitors at Liverpool and Manchester, to their admiration at Edinburgh. He made friends of Herschel, Sir Walter Scott, and "Christopher North," who has left the record of his warm admiration for the man and his work in two of his essays, and of Cuvier, Humboldt, and Saint-Hilaire in France. He resolved to go on with the publication of his works, although his friends advised him that the risk was too great to venture upon. In 1827 he issued the prospectus of "The Birds of America," to be published in numbers of five folio plates each, the whole to be included in four volumes, and to be sold for one thousand dollars a copy. The entire cost of the work would exceed one hundred thousand dollars; yet when the prospectus was published he had not money enough to pay for getting out the first number. With the aid of Sir Thomas Lawrence he sold some pictures, and was enabled to carry himself over this difficulty; and this led the way to his finding a regular means of support while his enterprise was going on, by painting. He visited Paris in 1828, canvassing for subscribers, and experienced an admiration from illustrious men parallel with that which had greeted him in England. But he does not appear to have appreciated the money value of this admiration as highly as what he found in England, for he wrote: "France is poor indeed! This day I have attended the Royal Academy of Sciences, and had my plates examined by about one hundred persons. 'Fine, very fine,' issued from many mouths; but they said, also, 'What a work! what a price! who can pay it?' I recollected that I had thirty subscribers at Manchester, and mentioned it. They stared and seemed surprised; but acknowledged that England, the little island of England, alone was able to support poor Audubon. . . . Now it is that I plainly see how happy, or lucky, it was in me not to have come to France first; for if I had, my work now would not have had even a beginning. It would have perished like a flower in October; and I should have returned to my woods, without the hope of leaving behind that eternal fame which my ambition, industry, and perseverance long to enjoy." Baron Cuvier was requested by the Academy of Sciences to make a verbal report on Audubon's "Birds," and he responded, describing the work "as the most magnificent monument which has yet been erected to ornithology." The author, having returned to his own country after his schooling in France, "thought he could not make a better use of his talents than by representing the most brilliant productions of that hemisphere. The accurate observation necessary for such representations as he wished to make soon rendered him a naturalist. . . . Formerly the European naturalists were obliged to make known to America the riches she possessed; but now Mitchell, Harler, and Bonaparte give back with interest to Europe what America had received. Wilson's history of the 'Birds of the United States' equals in elegance our most beautiful works on ornithology. If that of Mr. Audubon should be completed, we shall be obliged to acknowledge that America, in magnificence of execution, has surpassed the Old World." After spending the winter in London, Audubon returned to the United States in April, 1829, and made his way, interrupted by excursions in quest of birds, to Little Egg Harbor, New Jersey, and the "Great Pine Swamp" in Northumberland County, Pennsylvania, to his home in Louisiana, which he reached in November. His book, in the mean time, was going steadily on, and the first volume was published in London in 1830. It contained one hundred plates, representing ninety-nine species of birds, with every figure of the color and size of life. The whole work was completed in four volumes, in 1839. It contained four hundred and thirty-five plates, representing one thousand and sixty-five distinct specimens of birds—all, from the eagle to the humming-bird, of the size of life. Again, after three months at home, spent in hunting and drawing, he visited England in 1830, where he found that he had been elected a Fellow of the Royal Society of London, and on the 6th of May took his seat in the great hall, and paid his entrance-fee of fifty pounds, "though I felt myself that I had not the qualifications to entitle me to such an honor." He was shortly afterward joined by his wife, who accompanied him in his journeys to get new subscribers. In 1831, anticipating another tour of observation and study in the South, he visited Washington, to get letters of introduction to the commanders of frontier posts and officers along his route. All received him in the kindest manner. The winter of 1831–'32 was spent in East Florida, in what Audubon called a rather unprofitable expedition, but which furnished the material for several striking "episodes," as his accounts of the events have been designated.

In his subsequent journey Audubon visited the coast of Maine, accompanied by his family. According to Dr. Griswold's account,* although no reference to the circumstance is made in Mrs. Audubon's "Life," the cholera then prevailing in the country, he was taken sick in Boston and detained there for some time. Aside from his illness, his experience in Boston must have been of the most grateful character, for he wrote of it, "Although I have been happy in forming many valuable friendships in various parts of the world, all dearly cherished by me, the outpouring of kindness which I experienced in Boston far exceeded all that I have ever met with." With these kindnesses he associated the names of the men who lent to the Boston of that time its peculiar luster. Continuing his journey, he explored the forests of Maine and New Brunswick and the shores of the Bay of Fundy, and then went by schooner to the Gulf of St. Lawrence, the Magdalen Islands, and the coast of Labrador; and in the latter part of the season visited Newfoundland and Nova Scotia. In the ensuing spring, after nearly three years of travel and research, he went for the third time to England, where, and in Edinburgh, he lived a year and a half. As soon as the first volume of the "Birds" was published, Audubon began his "Ornithological Biographies," to accompany it; a work which, besides descriptions of the birds, contained reminiscences of personal adventure, with delineations of scenery and character. It was completed in five volumes (1831–'39). It has a literary and historical value apart from that which the accounts of the birds give it, in that it presents in language warm from his having been a part of the scenes, a virgin past of our country, and its forests

* "Prose Writers of America," p. 189.

and prairies, which can never be restored or so well described again. Having spent the winter of 1836–'37 at Charleston, with excursions to the sea-islands, Savannah, and Florida, Audubon, in the spring of 1837, sailed in a revenue-cutter for explorations in the Gulf of Mexico, of which he has left sketches of scenes in the Louisiana bayous, and in Texas. In 1838 he returned to Edinburgh, where he spent several months in preparing the fourth and fifth volumes of the "Ornithological Biography" and in finishing the drawings for the "Birds." In 1839 Audubon came back to the United States for the last time, bought an estate on the banks of the Hudson River, which he called Minniesland—now Audubon Park, and within the city of New York—and engaged in the preparation of an edition of the "Birds" in volumes of a reduced size. In this edition the matter was classified, a feature which had not been found practicable in the method of publication of the original edition. He had also had in hand for some time a book on the "Quadrupeds of America," for which he, his sons, Victor Gifford and John Woodhouse Audubon, and the Rev. John Bachman, of Charleston, South Carolina, had gathered much material. A trip to the Rocky Mountains had been planned in connection with this work, but Audubon was induced to give it up, after having gone as far as the Yellowstone River, on account of his age. The first volume of the "Quadrupeds," which was largely the work of his collaborators, was published in 1846, and the last volume in 1854, after Audubon's death. During the last four years of his life, Audubon became weak in mind, and not able to do any regular work. "The interval of about three years," says Mrs. Audubon, "which passed between the time of Audubon's return from the West and the period when his mind began to fail, was a short and sweet twilight to his adventurous career. His habits were simple. Rising almost with the sun, he proceeded to the woods to view his feathered favorites till the hour at which the family usually breakfasted, except when he had drawing to do, when he sat closely to his work. After breakfast he drew till noon, and then took a long walk. At nine in the evening he generally retired. . . . He was very fond of his grandchildren, and used often to take them on his knees and sing to them amusing French songs that he had learned in France when he was a boy. . . . After 1848 the naturalist's mind entirely failed him, and during the last years of his life his eye lost its brightness, and he had to be led to his daily walks by the hand of a servant."

Various estimates of Audubon's character and work, and accounts of his appearance have been given us, all to his praise. Dr. Griswold says, in his "Prose-Writers of America," that his highest claim to admiration "is founded upon his drawings in natural history, in which he has exhibited a perfection never before attempted. In all our climates—in the clear atmosphere, by the dashing waters, amid the grand old forests, with their peculiar and many-tinted foliage, by him first made known to art—he has represented our feathered tribes, building their nests and fostering their young; poised on the tip of the spray and hovering over the sedgy margin of the lake; flying in the clouds in quest of prey, or from pursuit; in love, enraged, indeed, in all the varieties of their motion and repose, and modes of life so perfectly, that all other works of the kind are to his as stuffed skins to the living birds. But he has also indisputable claims to a respectable rank as a man of letters. Some of his written pictures of birds, so graceful, clearly defined, and brilliantly colored, are scarcely inferior to the productions of his pencil. . . . From the beginning he surrendered himself entirely to his favorite pursuit, and has been intent to learn everything from the prime teacher Nature. His style as well as his knowledge is a fruit of his experience." His personal appearance, as a reference to his portrait will show must have been the case, was calculated to impress a visitor. He is described as having been tall and commanding in person, with a countenance which, from the sharp glance of his eye and the outline of his features, "suggested a resemblance to the eagle." He is believed, from his own account, to have been somewhat of a dandy while he was living at Perkiomen. "It was one of my fancies," he says, "to be ridiculously fond of dress; to hunt in black satin breeches, wear pumps when shooting, and dress in the finest ruffled shirts I could obtain from France." When on his hunting-tours, as he records in the relation of a visit to Niagara, he would allow himself to get into the plight of the poorer class of Indians, and worse, from not having, like them, plucked his beard or trimmed his hair in any way. "Had Hogarth been living, and there, when I arrived, he could not have found a fitter subject for a Robinson Crusoe. My beard covered my neck in front, my hair fell much lower at my back; the leather dress which I wore had for months stood in need of repair; a large knife hung at my side; a rusty tin box, containing my drawings and colors, and wrapped up in a worn-out blanket that had served me for a bed, was buckled to my shoulders. To every one I must have seemed immersed in the depths of poverty, perhaps of despair." Some explanation was needed to convince the landlord of the hotel that he was a suitable subject for entertainment, but it seems to have been satisfactory. Christopher North says of him in the "Noctes Ambrosianæ," as he appeared at Edinburgh: "The man himself is just what you would expect from his productions; full of fine enthusiasm and intelligence, most interesting in his looks and manners, a perfect gentleman, and esteemed by all who know him for the simplicity and frankness of his nature."

# CORRESPONDENCE.

## MORE ABOUT MEN'S AND WOMEN'S BRAINS.

*Editor Popular Science Monthly:*

SIR: In replying to a letter by me, published in the June number of this journal, Dr. William A. Hammond dispensed with the ordinary courtesy of discussion, and, at the same time, quite dexterously evaded the question at issue. He drops the "numerous, striking, and easily-detected sex differences in brain" which were "to be perceived at once" in comparing the two, and devotes himself to the one element of weight, which, so far as I know, no one has questioned, *provided* the relative body-weight is not allowed for between the sexes as it *is* in the *tables where* men alone are compared.*

Dr. Hammond quotes from various writers on anthropology to prove points with which my questions had nothing whatever to do. Some of his quotations are from authors whose theories are discredited by later investigations; others are simply unsupported assertions; while his display of dialectic pyrotechnics and personal innuendo are both interesting and amusing even to me, their victim, but they are certainly not argument.

The doctor acknowledges that he can not accept the offer I made him—to distinguish the male from the female brains of twenty specimens marked in cipher—thus corroborating my position and that of the able and unprejudiced anatomists and physicians who assured me that there exist no sufficient data upon which to make the bold (and to use the doctor's own words) "rough-and-tumble" assertions which have been made by him as to the "radical and easily to be discovered characteristic sex differences in brains." To cover this, he makes a proposition to me, which is entirely aside from the question at issue, and in the face of the fact that I have never said that I could perform any of these wonderful feats.

I am quite willing to say that I can not. And since the science of anthropology is as yet in its infancy; since its various students disagree; and since within the past few months one of its cardinal principles has been found to be unsound, I am all the less willing to accept the sweeping statements of Dr. Hammond in regard to his being able to tell "at once the difference between a male and a female brain" by "numerous, easily-discovered, natural sex differences"; because of which differences he asserts both the incapacity of woman to learn and the danger of allowing her to attempt studies and occupations which he holds are unsuited to her lower brain organization.

It is just here that I join issue with him. And I maintain that no anatomist or physician has a right to assume these radical differences to exist, and, upon insufficient and conflicting data, make positive statements calculated to restrict woman in the use of whatever brain capacity she may have.

He finds woman's brain deficient in gray matter he says. Why deficient? Because man has more than she, and of course he is always assumed to be the highest type. But in this connection I find that Meynert says, "It" (the gray substance) "is more abundant in the brains of animals than in that of man, and indeed the proportion of gray substance *increases the more remote the brain-type is from the human.*" The italics are mine.

"A nervous impulse takes, according to Helmholtz, about twelve times as long to travel through the gray substance as it does to be transmitted through the peripheral nerves."—Ibid.

Is this a reason why women are said to think more rapidly than men, or to have "intuitions" which, Dr. Hammond graciously says, "stand her in good stead for thought"?

The doctor once more uses as illustration the "well-known fact" that these characteristic brain differences are greater between the sexes, and more to woman's discredit, the higher we go in the scale of civilization.* This he uses again as evidence that woman has not utilized the opportunities which she has never been allowed to have. But here comes—a few weeks ago—the news that the assumption upon which this is based is all wrong.

The Terra del Fuegans' brains have been used to illustrate the low organization of brain possessed by the lower races of man. It was assumed that the anatomical differences between their brains and ours

* See Le Bon, "Schwalbe Neurologie."

| BODY-HEIGHT. | BRAIN-WEIGHT. |
|---|---|
| 148–158 centimetres. | 1,289 grammes. |
| 158–168 " | 1,328 " |
| 168–178 " | 1,373 " |
| 178–182 " | 1,387 " |

* This does not agree with Huschke and Le Bon, even upon the old theory and estimates.

The German average brain-weight is given as superior to the French, the former being 1,416 grammes and the latter 1,333, yet the estimated difference between the sexes is 222 grammes, for the French, and only 130 for the Germans.

were so marked and so well known as to be quite beyond further dispute.

The latest test reveals the somewhat startling fact that these great *race* differences, even, are unproved assumptions, and the Terra del Fuegan brain is now said to possess proportions and characteristics that *in no way* enable anatomists to distinguish it from that of a Caucasian of the higher races. Here is a revelation, indeed, as to the state of anthropological knowledge! Now all this is frankly stated and acknowledged by the able brain anatomists who have no axe to grind, and are anxious to follow truth, even though it may confound their own theories.

This latest discovery in anthropology gives a pretty clear hint as to the accuracy of the information to be had, not only as to sex differences, but as to whether "these sex differences are greater the higher we go in civilization."

Since the foundation itself is knocked from under the theory, it looks as if the superstructure also may possibly need to undergo more or less repair at no distant day. This is what I contend for. Not because I pretend to be a brain anatomist, nor even a thorough student of anthropology. I have made no such claim; but I have said, and I now repeat, that those who *are* both of these (and whose standing as such I do not feel called upon to defend against Dr. Hammond's "fine and noble scorn," more especially since one of these very men was recently referred to by him as "the leading brain-anatomist in New York"), who are careful and honest brain students and anatomists, assure me that the present state of knowledge can not justify any one in making the sweeping statements made by Dr. Hammond as to the "numerous, striking, easily to be detected sex differences in brain."

The doctor invites me, in a tone of triumph (although I repeat this is not the question, and no amount of rhetorical dust can hide that fact), to find in all the records a woman's brain which weighs as much as Dr. Chalmers's (fifty-three ounces). Then he asserts that no woman's brain has ever been weighed in all the world which, if healthy, weighed over fifty-six ounces, while Cuvier's (whose brain, by-the-way, he does not mention, was not a healthy one, and that a part of its weight was due to that sad fact), and Abercrombie's weighed more than fifty-six ounces, and Webster's, Lord Campbell's, and Spurzhiem's, came within two or three ounces of weighing as much.

Now, so far as I am able to learn from books and from the profession, the brain of no remarkable woman has ever yet been weighed, to pit against those of these remarkable men. The brain of a Sappho, a George Eliot, or an Elizabeth Cady Stanton, might possibly make as fair a show as those of these gentlemen; but, unfortunately, woman's brain is, at the present time, labeled to fit the tramps, hospital subjects, and unfortunates, whose brains have, so far, been weighed and analyzed, and *these* are what are held up as the fair representative of woman and her capabilities, as against the Cuviers, Websters, and Byrons.

I assure Dr. Hammond that I am quoting a gentleman of his profession, and a friend of his, when I say "this is wholly unjust and absurd. It is simply no test at all." But in this connection it is only fair to state that, taking both sexes in this class of brains—hospital and unfortunates—Weisbach found that in the frontal lobes, which Dr. Hammond says is the intellectual part of the brain,* the female brains were relatively larger than the males. The per cent being, males, 87·86, and females, 88·03; † while Meynert reports the cerebellum in this class of brains to be exactly alike in the sexes—41½ per cent each.

It is a significant fact that Welker and the more recent Italian writers differ 100 grammes in their estimate of the weight of Dante's brain. If this enormous variation of estimate is possible in an individual brain, it seems not wholly impossible that there may be room for corrections in estimates made on sex differences where it is only claimed that these same 100 grammes exist as an estimated sex difference covering many cases, nations, and conditions, and containing brains of only the most ordinary women.

But the doctor says, "Now let Miss Gardener and the twenty leading brain anatomists, etc., search the records of anthropology and their own immense collections for the brain of a woman weighing as much as the least of these—Dr. Chalmers." There is in Dr. E. C. Spitzka's collection a female brain to meet even this unreasonable requirement, and she was not a remarkable woman either. Unimportant as she was to the world, she not only met Dr. Chalmers, but gave a point or two in the matter of weight to Lord Campbell, Daniel Webster, and Spurzheim. Her brain weighed 54 ounces. Now I trust that

* I give these authorities, fully recognizing that in this case it is against my point to do so. Munk says, "Intelligence is located everywhere in the cerebral cortex, and nowhere in particular." "I wish to add, in corroboration of this view," says Meynert, "that no author of the present day would be likely to insist on one special seat of memory, for memory is the common property of all cortical cells and fibers, which are able to receive and conduct external stimuli of all sorts." When Meynert said "No writer of the present day would be likely to insist," etc., he did not know Dr. Hammond.

† "Pfleger insists on the relatively greater development of the hemispheres in man as compared with those of woman, the exact relation being as 795 to 787 on the scale of 1,000. Engel has shown that this assigns the larger cerebellum to woman during the prime of life."—Meynert's "Psychiatry," p. 56.

Dr. Hammond will not fly to the conclusion that I suppose this woman to have been the superior, mentally, of those remarkable men. I do not myself lay so much stress upon mere brain-weight as the doctor does, but I simply meet his case as a matter of charity, and because it is easy to do so.

One other point, and I am done for the present. I shall shortly review the matter at greater length in a more readable form. The doctor says: "I stated . . . that the human head does not grow after the seventh year. . . . Instead of *head*" (the italics are the doctor's, although he says the use of them is a feminine characteristic and most objectionable), "I should have said *brain*, and then the point involved would have been more correctly stated." Perhaps it would have been, although that, also, is questioned by competent authority, but for the moment I have nothing to say as to that.

It is unfortunate, however, that a "scientist" should permit himself to resort to this sort of trickery in words. Perhaps it would have been more exact to say brain instead of head in that connection, but the doctor did not say brain, *and he did not mean* brain at that time, and until he was absolutely cornered on that point. How do I know? Allow me to quote the rest of the sentence in which it occurred, and which I omitted before, only because I, unlike the doctor, was limited as to space, and thought verbosity unnecessary, not dreaming that he would resort to such a trick. Here is his original sentence: "A fact which is somewhat astonishing to those not aware of it is, that the head of a boy or girl does not grow in size after the seventh year, *so that the hat that is worn at that age can be worn just as well at thirty*." (I regret that I had to use italics here to call the doctor's attention to his own meaning, since he does not like italics. I do not myself; but there are times when they seem to be very necessary.)

Now, unless the doctor is in the habit of fitting his hats to his brains and not to his head, this last explanation is simply a bit of artful dodging, and surely unworthy of any one who is in search of simple truth.

Helen H. Gardener.

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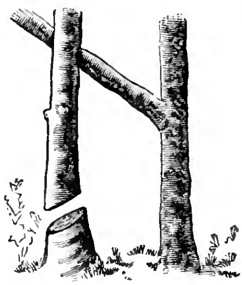
## AN ANOMALY IN PLANT-GROWTH.

*Editor Popular Science Monthly:*

Sir: There was to be seen in Stockbridge, Massachusetts, in 1841, and for several years afterward, a vegetable phenomenon which puzzled the rural observers and the few professed naturalists of the county. Two beech staddles, some six inches in diameter, grew within a foot of each other. About eight feet from the ground a lateral branch of one of them, growing tightly athwart the trunk of the other, had become incased by that trunk, so as to present the appearance of being thrust through it. Some one had cut off the absorbing stock two or three feet above the surface-soil, so that it hung by that lateral branch, and might be easily swung to and fro, thus:



The severed stock continued to live and grow, not only *above* the supporting limb, but *between the limb and the severance below.*

It was manifest that the top of the sundered tree was supplied through the transverse branch in the ordinary method of upward growth; but not so apparent how the *lower* portion continued its existence. If by the same agency, then seemingly by a reversal of the laws of vegetable circulation. It would not have been strange that shoots should appear on the severed stock the second season after the separation, since sap sufficient to start them might be retained in its tissues, particularly if the excision were done during the winter, which may have been the fact—this I do not know; but that this life should continue in the *lower* portion for successive years, is the mystery of the matter. I saw it during the third or fourth season after the separation, and can testify to life therein, though not the vigor of a thrifty young tree. The supporting trunk had increased much more than its mutilated companion. This shrinkage of vitality might have resulted in ultimate death, had not further experiment been precluded by the thoughtless removal of both for fire-wood by an ignorant chopper.

Will some of your learned correspondents explain to us rural marvelers this growth from downward-moving sap, or, apparently, from no sap at all obtained directly from mother earth?

E. W. B. Canning.

Stockbridge, Mass.

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## LITERARY SCIENCE.

*Editor Popular Science Monthly:*

Sir: In "The Popular Science Monthly" for February, 1887, you say: "Everybody, nearly, has been reading 'King Solomon's Mines,' but perhaps not very many have noted the startling fact recorded in it. The gifted narrator tells us how, shortly after the sun had sunk in the west, there came a glow in the east, and presently 'the crescent moon peeps above the plain'"; then you tell Mr. H. R. Haggard that it "won't do." Now I wish to call your attention to the fact that there must be people who think it will do, because, in "The Book-Buyer" for April, 1887 (Charles Scribner's Sons), in a short review of "Cathedral Days," by Anna Bowman Dodd, Mr. Edmund C. Stedman quotes a descriptive passage. He says, "Take this sunset picture with its felicitous touch at the close." The "felicitous touch" contains the following: "The work of the day for man and beast, and for the sun, as well, was done: all three were going to their evening rest. A boy with a sickle over his straight young back walked near us, whistling a gay little air. The sickle was repeated in silver in the sky, the dawning crescent of the young moon cleaving the *eastern* horizon." I do not like Mr. Haggard's books; they are as sickening as raw meat. But he has been rated so soundly on that one mistake that I wish it noted that others, and educated people, too, can make the same blunder.

Yours respectfully,

ANNE M. JOHNSON, 494 Centre Street.

JAMAICA PLAIN, MASS.

# EDITOR'S TABLE.

*CULTURE AND CHARACTER.*

THAT intellectual superiority is not an end in itself is apparent from more than one consideration. Comte has said with truth that "we get tired of knowing, but never get tired of loving"; and a writer who carries more authority still has said that, when tongues fail and knowledge ceases, charity will still abide. What seems to decide the question, however, is the fact that, when knowledge or intellectual power is made an end in itself, the result is more or less failure and disappointment. "Knowledge comes, but wisdom lingers," the poet has said; and, to a reflective mind, the distinction between the two is not difficult to seize. He who has knowledge only, knows things and their relations; himself and his relations, above all himself in his relation to the true human ideal, he does not know. He seeks to make his knowledge subservient to his own personal ends; he does not regard it as a revelation of duties to be done, of sacrifices to be made, of heights to be attained. He who has wisdom, on the other hand, holds his knowledge in trust for higher than personal ends, and makes us realize, as other men do not, the true value and dignity of knowledge.

Character, then, is the principal thing. It is character that we continually find to be limiting and conditioning culture; that is to say, if culture is not carried farther than we find it to be in certain cases, the reason is that the character, the moral nature, has not been such as to support and sustain a truly generous culture. There is, perhaps, a finely-developed æstheticism in certain directions, but the lack of culture's perfect work is seen in a certain hard materialism of personal aspiration. The disciple, perchance apostle, of beauty is far from beautiful when we get a glimpse of his inner life and essential aims. He has never learned that the prime secret of all beauty in human life lies in *disinterestedness*, in the ability to put self aside, on some occasions at least, and to live in causes and principles and, above all, in one's fellow-beings. Few things are more trying than the mock enthusiasm of very mediocre men and women for things that they have learned to admire as by rote, to hear the jargon of the literary or artistic coterie and to know how little it all means as regards real elevation of character and sentiment. And what we say of literary and artistic coteries we might apply with equal truth to scientific coteries, where minute points of classification and nomenclature are discussed with infinite zeal and warmth, but with far less regard to any advantage to be reaped for the cause of truth and of humanity than to the satisfaction of rival vanities.

In this country we are laboring with great zeal and vast pecuniary resources to promote the cause of culture. We educate, educate, educate, as somebody once said we ought to do; but whether the result is to produce much that can be called culture in any high sense is an open question. A criterion may, perhaps, be found in a comparison of the rising with the now adult generation. Are our young people showing graces of mind and character in more abundant measure than their parents? Are their aims higher? Is their language better? Are their intellectual occupations more serious? Are their manners gentler and more refined? We do not propose to answer these questions dogmatically; but this we say, that, unless there has been an improvement in these several respects, a vast amount of educational effort has not met its full reward. Speaking broadly, it seems to us that the culture of our educated classes, or of the classes supposed to be educated, leaves much to be desired, and we are disposed to think that one reason of this is that we have conceived of education in too purely an intellectual sense. We have thought more of sharpening the thinking faculties than of liberalizing the sentiments or softening the manners. We have introduced too much of rivalry into education, and represented education too much as a preparation for further rivalry in after-life. We have imparted knowledge, but have only to a very moderate extent succeeded in inculcating wisdom; and knowledge without wisdom seems poor, thin, and sometimes even meaningless. We need, as it seems to us, to devote more consideration than we have hitherto done to the question, What is the true ideal of human life? If we can fix upon the true ideal, we can proceed to educate toward that, and our work will then be directed toward something that is an end in itself. The knowledge we impart will be held by a different tenure, and applied in a different spirit. What each one knows will be his or her equipment toward a worthier fulfillment of social duties, a worthier realization of what is best in himself or herself, and not a mere stock-in-trade for the procuring of personal gratifications. What we would chiefly insist upon at present, however, is that, were knowledge pursued in a right spirit, the intellectual gain would be very great. Minds would become more receptive, owing both to the superiority of the motive set before them, and the higher degree of rationality that the whole system of human life and thought would assume. Civilized speech would not show a constant tendency to degenerate into a jargon of slang, if people recognized in speech a social function, not merely a mode and means of self-assertion. It is impossible to find one's self in any fortuitous assemblage of average human beings without being led to reflect how much human intercourse might be improved and beautified if, by some means, we could implant in the mind of each individual a true respect for the rights and feelings of others, and a general sense of what is due to society, considered as the source of unnumbered advantages to all its members. At present it often seems to be a distinct aim with many persons—and these not in any sense social outlaws, but, on the contrary, what would be called "respectable people"—to show how little they care for anything beyond their own pleasure and convenience. The popular idea of "independence," indeed, is largely made up of swagger and aggressiveness; whereas the most primary notion of independence should embrace the making of an honest return for all good received. Thus viewed, the man who wished to be "independent" would see that society got back from him in service something like a compensation for the benefits with which it surrounds him by day and by night. But "independence" in this sense is absolutely inconsistent with swagger or any form of unsocial action or sentiment. We can conceive of some philosophic mind saying to this great nation, "One thing thou lackest." Knowledge we have, and material power and business energy, and back of all this, no doubt, a great fund of true humanity. But the lack is in consciousness of the true aim of life, which is beauty and harmony in all social relations. The voice of Science itself bids us make a true generalization, a true synthesis, before we begin to work out our plans. We have hitherto stopped short too much at the idea of knowledge as an instrument of work and ambition, and have greatly hindered the growth of knowledge thereby. If we now set before us as our main object the building up of character in all its elements, we shall find our progress sure, if not rapid, and shall discover a deeper meaning and value in our labors from year to year and from age to age.

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### *THE TYNDALL BANQUET.*

The dinner given to Professor Tyndall in London on the 29th of June, on the occasion of his retirement from his professorship in the Royal Institution, was also intended as a testimonial to the value of his work in the advancement of knowledge. The two hundred guests who participated constituted, according to the English papers, "as large and distinguished a company as ever assembled to do honor to a man of science"; or were "men who have rendered themselves notable in the pursuit and application of the most diverse forms of knowledge." It is questioned if English science has ever been more completely represented than at this banquet, where "the tables were crowded with men whose names are known wherever Nature is studied." Other men, equally eminent and equally representative in various fields, sent letters attesting their hearty concurrence in the honor intended for the investigator and teacher. British public life was represented by Lord Salisbury and other prominent men; literature, by Lord Lytton; and the United States, by Professor Asa Gray. Professor Stokes, President of the Royal Society, presided; and the presidents of several scientific societies were vice-chairmen.

Various reasons were given in the addresses why Professor Tyndall should be particularly honored. The chairman described his researches; Lord Lytton dwelt upon the value of his scientific writings as contributions to literature; Sir Lyon Playfair and the Earl of Derby spoke of the obligations the public service was under to science.

But Professor Tyndall's researches and discoveries were not considered his only claim to recognition. The feeling seemed general that the world was under peculiar obligations to him, of a higher character, because he had made science accessible to the public and attractive to the general reader. Professor Stokes insisted upon the importance, to the general diffusion of science, of expounding its leading principles and results, whether by lectures or by treatises, in which, while they are scientifically sound, popularity of style and general readableness are not sacrificed. Most of those present had had opportunities of being impressed with Professor Tyndall's lucid style and graphic expression in expounding to audiences the salient points of the scientific subject which he brought before them; and the same qualities were apparent in his books.

"Nature" also gives prominence to this feature of Professor Tyndall's work, saying that "if the wide-spread knowledge of science was to be, as it is, an essential condition of national well-being, it was absolutely necessary that the people should know something of, and be in some sort of sympathy with, the methods and conditions of scientific thought. In supplying this need, Professor Tyndall's greatest work has been done. . . . He has, by his lectures and his books, brought the democracy into touch with scientific research. . . . He has done, perhaps, more than any other living man to compel those who regard knowledge as valuable only in so far as it is immediately useful, to admit that the seed which is sown in the laboratory often produces the most abundant harvest in the workshop." The "Times" thinks it not too much to say that the thirty-four years of Tyndall's occupancy of his professorship "have effected more than almost any other contemporary influence to diffuse a love of scientific knowledge among large classes of the community, and to prepare them for the acceptance of many ideas which, at least in their earliest forms, appeared to run counter to others which had been universally received."

We do not suppose that these thoughts are new in England; only that they have just now been given formal, authoritative expression. With reference to Professor Tyndall, they are familiar in the United States, where they were spoken fourteen years ago at a similar banquet given to him at the close of his lectures here; a banquet which was parallel in its significance and the diversified representative character of its company with the one in London. On this occasion, Professor Henry wrote that Professor Tyndall "is not only a distinguished laborer in the line of original research, but also one of the best living expounders of scientific principles. His books . . . have done more to give precise and definite knowledge of the principles of the sciences of which they treat than any other series of works ever published." Professor Safford, of the Dearborn Observatory, said he had shown us "how to employ extensive and deep researches in conveying a maximum of instruction to the world at large"; and Professor Jeffries Wyman desired to honor him "for his many contributions to physical science, and for his strict devotion to the exact methods of bringing scientific truths to light."

Among other features of the addresses at the London dinner deserving special notice are the Earl of Derby's admission that the gains we have derived from the applications of science —great as they are—are as nothing compared with those accruing from the acceptance of scientific habits of thought; and his significant assertion that British politicians have done the best they could for science—"they have let it alone; they have not corrupted it by their intrigues, nor vulgarized it by their squabbles; and they being what they are, and science being what it is, that is probably the best service they could have rendered it."

### *HONEST LIFE-INSURANCE.*

UNDER the title of "Lawsuit or Legacy," we published, in the July "Monthly," an article reflecting somewhat sharply on the one-sidedness which still survives in many life-insurance contracts; and also alleging that it is not an uncommon practice for the companies, taking advantage of some qualifying technicality in their policies, to resist the payment of death-claims by menacing or openly attacking the character of the deceased. "Millions of dollars," says the writer of the article, "have been withheld from rightful heirs by threats of an exposure—the more vague, the more frightful—of unsuspected crimes and misdeeds of the beloved dead"; and, again, that "thousands of cases, never known to the public, have been compromised, and hundreds of heart-aches and unjust suspicions and fears about the dead which can never be corrected, are aroused in sorrowing but loving breasts by this method of doing business."

In commenting on the article, "The United States Review" takes exception to these statements, claiming that they are not only totally inconsistent with ordinary business self-interest, but contrary to the facts, and otherwise unjust to the companies. Having no concern in the matter beyond a desire that the public shall be accurately informed on the subject, we quote a part of what the "Review" says on this point, premising that, while it writes in the interest of the insurance companies, the tone of its article is both fair and reasonable: "It is only just to say that the companies now doing business in this country have paid over ninety-nine and one half per cent of the death-claims which have been presented without question, and they have paid a large proportion of the remainder without litigation. When it is remembered that certain cases of fraud arise which it is the duty of an honest management to unearth and expose, the proportion of claims resisted is small. All cases of compromise are brought within the limits of the foregoing statement. It is to-day a most unusual thing for a company to contest a claim. Indeed, we can point to an office founded twenty-two years ago which has never yet appeared as defendant in a suit to recover under one of its policies."

## LITERARY NOTICES.

History of the Pacific States of North America. By Hubert Howe Bancroft. Vol. I. Central America, 1501–1530. San Francisco: The History Company. Pp. 704. Price, $5.

Though late in the order of actual publication of the series of histories, this volume is the first in the order of classification, and therefore rightly receives that number when regarded with reference to the series as a whole. The author's plan of logical arrangement is to begin at the south of the territory whose history he intends to record in the whole work, and advance toward the north; and this order corresponds in the main with the historical sequence. The volume is introduced by a general preface, giving a short summary of the plan of the whole series, and an elucidation of the theory on which it has been composed; matters which have already been discussed at length in our pages. The author avows the peculiarity of his method of work to consist in the employment of assistants, to bring together by indexes, references, and other devices, all existing testimony on each topic to be treated, whereby he obtains important information, which otherwise, with but one lifetime at his disposal, would have been beyond control. Acknowledgment is now made by name to five of these assistants. The amplitude in volume of the work is chargeable, the author says, "to the immense mass of information gathered rather than to any tendency to verbosity. There is scarcely a page but has been twice or thrice rewritten with a view to condensation; and instead of faithfully discharging this irksome duty, it would have been far easier and cheaper to have sent a hundred volumes through the press." The character and customs of the aboriginal inhabitants of the country at the time they were first seen by their subduers, and what can be gathered respecting their previous history, are discussed in the volumes on "The Native Races of the Pacific States," which are regarded as constituting a separate work from this. The "History" series, including the present volume on Central America, begins, therefore, with the Conquest, without reference to the matters treated of in those volumes. For the "History of Central America," besides the standard chroniclers and the many documents of late printed in Spain and elsewhere, the author has been able to secure a number of valuable manuscripts nowhere else existing, including some from the Maximilian, Ramirez, and other collections, with all of Mr. E. G. Squier's manuscripts relating to the subject. Much of the material has been drawn from obscure sources, from local and unknown Spanish works, and from the confused archives of Costa Rica, Honduras, Nicaragua, Salvador, and Guatemala. The introductory chapter gives a general view of Spain and civilization at the beginning of the sixteenth century. The course of discovery is then followed up, with accounts of Columbus and his discoveries, the discovery of Darien, the further explorations of Columbus, the administration of the new colonies, the discovery of the Pacific Ocean, etc.; then the stages of further colonization and conquest, till the downfall of the Quiché nation, whose capital is described, and of the Cakchiquels and Zutugils, in 1524; and the volume closes with the account of the revolt of the Cakchiquels, in 1524–'25. The publishers inform us that an Eastern agency for Mr. Bancroft's works has been established, under the direction of Mr. F. M. Derby, at 149 Church Street, New York.

A History of Modern Europe. By C. A. Fyffe. Vol. II, from 1814 to 1848. New York: Henry Holt & Co. Pp. 513. Price, $2.50.

A comparison of the condition and policies of the chief civilized nations as pictured in this book, with the present aspect of Europe, will help to give a realizing conception of the extent to which the world of politics and government has moved during the last forty years. We are slow to comprehend how fast we are making history till some survey of the recent past like this brings vividly before us what has happened in our own lifetime. The period whose events are recorded in the present volume of Mr. Fyffe's history, may be described, as in its earlier years, the period of reaction. It was the aim of its statesmen to restore Europe to the despotic *régime* which it endured before the French Revolution. Nationalities were cut up or combined, without a thought of how their people would be affected, to suit the ambitions and convenience of sovereigns and ministers whose chief aim was to crush out all life of freedom and enforce the asserted divine right of the few to govern and tax the many. The achievement of Grecian independence was a rude interruption to the successful pursuit of this policy; the French "July Revolution" of 1830 was a dangerous break in it; and the Revolutions of 1848 were the sign of its ultimate defeat, and of the ushering in of the present era when consideration of the desires and interests of the people is becoming more and more the accepted theory of the governments. The four leading features we have mentioned, in their order, constitute the framework on which Mr. Fyffe has wrought his history. The story is told with brevity and clearness.

Principles of Education Practically Applied. By J. M. Greenwood. New York: D. Appleton & Co. Pp. 192. Price, $1.

The author of this book is Superintendent of Schools of Kansas City, Missouri. His motive in preparing it has been to help teachers to do better and more intelligent work in the school-room. It assumes that education is a science; and that school-teachers can understand the principles of the science, and apply them accurately in their daily work to the children under their control. The object of the work throughout is to impress upon the mind of the teacher the question, "How shall I teach so as to have my pupils become self-reliant, independent, manly men and womanly women?" The foundation of the essay is laid in a chapter insisting on the application of the principles of psychology to the work of teaching; and this is to be made in the study of the temperaments of the children and the application of certain fixed educational principles in such a way as to secure an orderly and free development of the faculties. The succeeding chapters are of a more practical and concrete character, and show how the objects aimed at may be promoted in general school and class management, in methods of conducting recitations, in questioning, and in teaching the particular branches of reading, composition, and language, penmanship, geography, history, and arithmetic. Another chapter is devoted to "Health and Hygiene"; and studies of several typical boys are presented in the concluding chapter.

Sociology. By John Bascom. New York: G. P. Putnam's Sons. Pp. 264. Price, $1.50.

This is not a treatise on sociology conveying a full and systematic discussion of the subject, but rather a bundle of essays on a number of topics of a sociological bearing. "It passes familiar principles, and principles to which the author can make no important additions, and concentrates attention on points at which he is best able to reward it; and this with only secondary reference to general symmetry." Predominant interest is shared in questions of immediate moment to society. The author confesses to have covered a large field suggestively rather than a narrow field exhaustively; and he believes that that method is often "to be deliberately preferred in practical value, though it may involve a loss in personal estimation." In the introduction, the complexity of the facts of sociology is illustrated, and the relation of the social sciences to one another is considered. In the succeeding chapters are discussed the power of custom and its relation to law and public opinion; the development, operation, and function of government; the "three axioms" of political economy; the development of religion; ethics, its relation to customs and economics, and the connection of ethical law with government and religion; and various social problems, including the rights of women, prohibition, public education, equal civic advantages, franchises, laws of entail and inheritance, competition, the mission of the pulpit, and socialism.

Health of our Children. Pp. 128. Price, 75 cents. Health in our Homes. Price, 75 cents. A Household Guide in Health and in Disease. Pp. 460. Price, $3. Boston: Thayer Publishing Company. Cupples & Co., Wholesale Agents.

The first two of these volumes have been compiled from a series of letters for popular reading, which were published in one of the newspapers of Boston. The first, a book of "practical advice to mothers," is based on the conviction that two thirds of the cases of illness among children arise from preventable causes, and aims to put before the reader, in the simplest manner possible, the important essentials in the care and management of children. The second treats of the faults tending to the production of disease which exist in many of our homes, and advises the application of those improvements and sanitary precautions by means of which a large part of the sickness now experienced may be avoided. The leading design of the "Household Guide" is to place before the reader those established principles, a knowledge of which is essential to the preservation of health, and to recovery when suffering from disease. Under the head of "Practical Hygiene" are considered the most common substances used for food, and their peculiar action; the laws of diet; personal hygiene, with the purpose of promoting correct physical habits. A chapter on mental hygiene treats of the intellectual operations and the relationship between the mind and the body. A third part relates to the sick-room and its general management, with chapters on nursing and the dietetic treatment of the sick. Under the heading of the "Principles of Medicine" are considered the symptoms and causes of disease, and medicines and their administration. The practice of medicine is taken up and described in its applications to diseases of the respiratory, circulatory, and digestive systems, the stomach and intestines, the abdominal organs, the nervous system, fevers, "general diseases," and "accidental disturbances."

Elements of Botany. By Edson S. Bastin. Illustrated. Chicago: G. P. Engelhard & Co. Pp. 282. Price, $2.50.

The author believes that there is need for some work on botany better adapted to the wants of our higher schools than any in present use; as well as of a work which is not so technical but that any student of fair intelligence may take it up without the aid of a teacher, and obtain a good foundation-knowledge of the facts and principles of the science. He has endeavored to supply such a book. He has aimed to make the text simple and free from unnecessary technicalities, and, in the order of arrangement of subjects, to lead the mind of the pupil from that which is familiar to what is less so. Hence those features in structure are first presented which may be understood without other aids than good eyes, nimble fingers, a pocket-knife, and a magnifier, before inviting attention to more delicate points. The organs are therefore treated of in the first part, as organs of vegetation and of reproduction. Vegetable histology is next presented, and is followed by the chapters on vegetable physiology and vegetable taxonomy. As subjects for study and description those plants are selected which are either familiar to most students, or which may be readily found and identified by means of the descriptions given in the text. Illustrations are freely used, and the figures are all drawn with the author's own hand.

Natural Law in the Business World. By Henry Wood. Boston: Lee & Shepard. 1887. Pp. 211. Price, 75 cents.

In its way, and so far as it goes, this is an excellent book. It is in no sense original, the truths it teaches being already famılar to students of economics. Indeed, the author makes no claim to originality, but characterizes his work as "an honest effort to trace out the working and application of natural law, as it runs through the economic and social fabric, in a plain and simple, though, it is hoped, practical manner." He speaks of himself as having had only a practical business training, though it is evident that he is familiar with the standard economic writers; and his literary style, if not so polished as some, is characterized by clearness and a certain epigrammatic point which makes some of his expressions very effective.

Mr. Wood is a thorough disbeliever in social nostrums and in all plans of reform that run counter to natural law. He says: "The ills of our social system, the hardships of labor, and the inequalities of fortune, can not be got rid of by any short-cut route of social revolution or industrial transformation. Circumstances and conditions may change, but principles never. Wealth has always been the natural sequence to industry, temperance, and perseverance, and it will always so continue." He calls attention to the fact, so obvious to all thinking men, but so often overlooked or ignored by agitators, that brain-labor is far more important to the world than hand-labor, and consequently that the assertion so often made, that all wealth is the product of manual labor, is not true.

Of course, the author condemns socialism in unsparing terms; but he evidently has no fear of its being practically adopted. He is also strongly opposed to labor-unions, and seems to think there is almost no good in them. He declares that "their entire action and effort are in the direction of vainly trying to combat the natural principle of supply and demand" (page 53). He also condemns them because they interfere with the free action of the individual laborer, are tyrannous toward non-unionists, and antagonistic to capital. In what he says on this subject there is much that is true, and would be profitable for labor agitators to read; but, like all who take a similar view of the matter, he seems to forget that the labor-unions themselves are a product of natural law just as truly as corporations are, and that they would not have grown up and lasted so long if there were not some solid foundation for them.

The author has done well to call attention once more to the reign of natural law in economic affairs; and if his work is not quite satisfactory, it is because he has too much overlooked the reign of moral law in the same field. We can not prosper economically unless we conform to economic laws; but neither can we unless we conform to moral laws, so far as these are involved in the production and distribution of wealth. On one point of business morality, indeed, the author speaks out in emphatic language in regard to the conduct of railway directors in speculating in the stock of their roads. His view is that "railroad managers control a valuable *trust*, and, if they profit by their superior knowledge, to the detriment of other stockholders, it is a moral wrong, which it seems proper to make a legal offense." If this principle had actually been applied in our industrial history, many of the colossal fortunes now existing in the country would never have been accumulated; and this shows the importance of moral law in the business world.

Henry Draper Memorial. First Annual Report of the Photographic Study of Stellar Spectra, conducted at the Harvard College Observatory. Edward C. Pickering, Director. Cambridge: John Wilson & Son. Pp. 10, with Plates.

Mrs. Henry Draper, early in 1886, made a liberal provision for carrying on the photographic investigation of stellar spectra at the Harvard College Observatory, as a memorial to her husband, who did the first work of this kind in 1872, and continued it with great skill and ingenuity till his death, ten years later. The results of the year's work have been so encouraging, that Mrs. Draper has decided greatly to extend the original plan of work, and have it conducted on a scale suited to its importance. The attempt will be made to include all portions of the subject, so that the final results shall form a complete discussion of the constitution and conditions of the stars, as revealed by their spectra, so far as present scientific methods permit. The investigations already undertaken include a catalogue of the spectra of all stars north of $-24°$ of the sixth magnitude and brighter, a more extensive catalogue of spectra of stars brighter than the eighth magnitude, and a detailed study of the spectra of the bright stars. The report describes the instruments which are employed and the methods of observation, and gives accounts, illustrated by a plate, of the studies of five bright stars. The whole field of studies is intended to comprise catalogues and classification of the spectra of bright and faint stars, determinations of the wave-lengths of the lines, comparisons with terrestrial spectra, and an application of the results to the measurement of the approach and recession of the stars. Special photographic investigations will also be undertaken of the spectra of the banded stars, and of the ends of the spectra of the bright stars.

A Modern Zoroastrian. By Samuel Laing. London: F. V. White & Co. 1887. Pp. 265.

This book, like many others of late years, is evidence of two facts: first, that the traditional religion has lost its hold on most scientifically educated minds; and, second, that such minds are not content without some religion. In Mr. Laing's view all religions are "working hypotheses, by which successive ages and races of men try to satisfy the aspirations and harmonize the knowledge which in the course of evolution have come to be for the time their spiritual equipment." But when the "environment changes, when loftier views of morality prevail, when knowledge is increased, and the domain of science everywhere extends its frontier, religions must change with it if they are to remain good working, and not become unworkable and unbelievable hypotheses." That Christianity has become an unworkable hypothesis the author endeavors to show by the arguments that others have used for that purpose. He dwells particularly on such impossible doctrines as the Trinity, and also on the miracles which form so important an element in historical Christianity. He does not pronounce miracles impossible, but thinks that, as they are contrary to all we know of the course of Nature, they can not be believed without the most indubitable evidence of their occurrence, and such evidence is not forthcoming.

Moreover, Mr. Laing is troubled by the existence of evil, and hence he is unable to believe in the personality of the First Cause, since an omnipotent personal Creator must, in his opinion, be the cause of the evil as well as the good. His view of the First Cause is similar to Herbert Spencer's; but he thinks it necessary that our religious doctrine should frankly recognize the existence of evil as a fundamental constituent of the universe—proceeding, like good, from the unknowable First Cause. The antithesis of good and evil he seeks to identify with the principle of polarity in the material world, hoping thereby to bring it under a general law of the whole universe. He devotes several chapters to an account of this principle, beginning, of course, with the magnet, and then proceeding to the world of life and to those of morals and politics. He treats the antitheses of plant and animal, of male and female, and of heredity and variation, as examples of polarity, and regards the progressive and conservative tendencies in politics as another instance of the same principle. And, finally, the antithesis of good and evil is brought under the same category, so that in the author's view evil no less than good is an essential element in the universe. Such being the case, he says: "Now of all the religious hypotheses which remain workable in the present state of human knowledge, that seems to me the best which frankly recognizes the existence of this dual law, or law of polarity, as the fundamental condition of the universe, and, personifying the good principle under the name of Ormuzd, and the evil one under that of Ahriman, looks with earnest but silent and unspoken reverence on the great unknown beyond, which may, in some way incomprehensible to mortals, reconcile the two opposites, and give the final victory to good. . . . This, and this alone, seems to me to afford a working hypothesis which is based on fact, can be brought into harmony with the existing environment, and embraces, in a wider synthesis, all that is good in other philosophies and religions."

Mr. Laing does not deny the excellent moral elements to be found in Christianity; but he thinks that there are also serious moral deficiencies in it, and that Zoroastrianism has "the most complete and comprehensive code of morals to be found in any system of religion." Moreover, he thinks that Christians at the present day are really worshipers of the good principle as personified in Christ; or, in other words, that "modern Christians are, to a great extent, without knowing it, worshipers of Ormuzd, with Christ for their Ormuzd"; and this he regards as an excellent thing, and perfectly in harmony with his own principles. Of course, Mr. Laing recognizes the fact that the Zoroastrian religion can not be adapted to modern needs without some changes; but he thinks it requires fewer changes than any other ancient religion, while it can at the same time absorb into itself all that is good in the others. We should add that the author's views are well expressed; the printer's part of the work has been well done; and readers having a taste for this class of subjects will find the book an interesting one.

The Story of Metlakahtla. By Henry S. Wellcome. New York: Saxon & Co. Pp. 483. Price, $1.50.

This story is intended to excite sympathy. A tribe of savage Indians living in British Columbia, near the Alaska line, has been Christianized and civilized under the missionary efforts of the Rev. William Duncan, several thousand souls being comprehended under the influence of the work. An Anglican bishop has attempted to impose upon them a ritual and discipline which they reject, and the Colonial Government has taken land which they claim and given it to the Church Missionary Society. Their appeals for recompense having been refused, they are now seeking to remove in a body to Alaska, within the territory of the United States. The story of their claims and alleged wrongs is told in detail, with numerous references to official documents and public correspondence.

A History of the Doctrine of Comets. By Andrew D. White. New York: G. P. Putnam's Sons. Pp. 43. Price, 25 cents.

This is a fuller version of the author's essay, which was published, as the first of "New Chapters in the Warfare of Science," in the "Monthly" for October, 1885, and was read at the meeting of the American Historical Association in September of the same year. It is published in substantial form, on thick paper, and with clear, open type, as No. II, Vol. II, of the "Papers of the American Historical Association." With its copious citations from authors and notables of every age, and of the most curious theories and opinions on the subject, it is a paper of rare interest.

Dinocerata: A Monograph of an Extinct Order of Gigantic Mammalia. By Othniel Charles Marsh. Washington: Government Printing-Office. Pp. 243, with Fifty-six Plates.

This memoir is the second in the author's series of monographs on the extinct vertebrate life of North America. The first volume described the *Odontornithes*, or birds with teeth, of the cretaceous deposits on the eastern slope of the Rocky Mountains. The present volume contains the record of a peculiar order of mammals, which Professor Marsh has brought to light in the early Tertiary strata of the great central plateau of the continent. Their remains have hitherto been found in a single Eocene lake-basin in Wyoming, and none are known from any other part of this country, or from the Old World. This lake-basin, now drained by the Green River, slowly filled up with sediment coming from the Wahsatch, Uintah, and Wind River Mountains, but remained a lake so long that the deposits formed in it, during Eocene time, reached a vertical thickness of more than a mile. It has since been subjected to a vast erosion, by which it has been carved into the picturesque Bad Lands; and this erosion has brought to light the remains of many extinct animals, among which the bones of the *Dinocerata*, from their great size, attracted particular attention. Among the other animals represented were ancestral forms of the modern horse and tapir, and of the pig. Many others were found related to the recent lemurs; also various carnivores, insectivores, rodents, and small marsupials; remains of a new order of mammals, the *Tillodonts*, quite unlike any now living. Crocodiles, tortoises, lizards, and serpents swarmed in and about the waters of the lake, while around its borders grew palms and other tropical vegetation. The picture is finished with the conception of the *Dinocerata*, or terrible horned, gigantic beasts, which nearly equaled the elephant in size, and roamed in great numbers on the shores of the lake. They form a well-marked order in great groups of the *Ungulata*, or hoofed animals. In some of their characters they resemble the Artiodactyls (*Paraxonia*); in others they are like the Perissodactyls (*Mesaxonia*); and, in others still, they agree with the Proboscidians. The points of similarity, however, Professor Marsh adds, are in most cases general characters, which point back to an earlier, primitive ungulate, rather than indicate a near affinity with existing forms of these groups. The number of species is difficult to determine. About thirty forms, more or less distinct, are recognized in the synopsis at the end of the volume; but the number might be increased, if fragmentary specimens were used as the basis for specific names. The specimens which are now in the museum at Yale College represent more than two hundred individuals of *Dinocerata*. Of these, not less than seventy-five have portions of the skull more or less preserved, and in more than twenty it is in good condition. The author has endeavored in his plates, and nearly two hundred woodcuts in addition, to give accurate illustrations of type specimens; and all the important specimens now known are represented, and at least one figure is given of every species.

The New Crisis. By George W. Bell. Des Moines, Iowa: Moses Hull & Co. 1887. Pp. 350.

The object of this book, as the preface declares, is "to prove the existence of a class conspiracy, the design of which is to subvert the principles of our Government by a monopoly of wealth." In other words, it is an anti-monopoly polemic, and has the usual characteristics of such works in a somewhat extreme form, but with little in it that is specially new.

Infants, their Chronological Progress. By Professor Stanford E. Chaillé, M.D. Pp. 20.

Believing that the inquiry is useful with reference to many points, Dr. Chaillé has collated in this pamphlet, as nearly in their order as may be, the various manifestations of infant life, activity, consciousness, and disposition, from birth up to the age of three years. This record is followed by notes on the color of the eyes and hair, and on growth as shown by height, weight, and chest-girth.

Results of the Observations made at the Blue Hill Meteorological Observatory, Massachusetts, in 1886. By A. Lawrence Rotch. Pp. 45, with Plates.

The Blue Hill Observatory is a private establishment, which is claimed to be one of the best-equipped meteorological stations in the United States. It is situated on Great Blue Hill, Norfolk County, Massachusetts, at an elevation of six hundred and thirty-five feet, making it the highest point within ten miles of the Atlantic coast from Maine to Florida. The present report gives a full account of the equipment of the observatory, and records of "general results," prevalence of winds, velocity of winds, and atmospheric pressure, for every day of the year, with annual summaries under each head, and several plates of tracings.

Elementary Microscopical Technology. Part I. The Technical History of a Slide. By Frank L. James. St. Louis: Medical and Surgical Journal Company. Pp. 107. Price, 75 cents.

The present number is a part of a work on general microscopic technology, the other parts of which will appear in time. It is intended to teach in detail the processes and manipulations for preparing the materials for a microscopic mount. For this purpose it takes the crude materials—the object to be mounted, the chemicals, gums, bits of glass, etc., entering into the structure of a slide—and carries them by minute descriptions through the processes of hardening (or softening), imbedding, section-cutting, staining, etc., up to the final mounting for the cabinet. It is purposed thus to give the student a general outline idea of the work, and a knowledge of the names, uses, and functions of the instruments and materials used. Each stage and process is taken up in detail and in the order of occurrence in actual work; so that nothing is taken for granted, and no previous acquaintance of the student with the subject is supposed.

The Treatment of Sewage. By Dr. C. Meymott Tidy. New York: D. Van Nostrand. Pp. 224. Price, 50 cents.

Dr. Tidy's researches on this subject are probably more widely known and more frequently quoted from than those of any other single author. He has made special studies through many years of the question of the disposal of the sewage of London. This manual gives the more important results of those studies, as they were presented by the author in a paper to the English Society of Arts.

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## PUBLICATIONS RECEIVED.

Harris, William T. How to teach Natural Science in the Public Schools. Syracuse, N. Y.: C. W. Bardeen. Pp. 40. 15 cents.

Kaine, J. L., Milwaukee, Wis. Conditions of Health in Cities. Pp. 18.

Marvin, J. B., M. D., Louisville, Ky. Renal Colic, Parasitic and Calculous, "A Criticism." Pp. 28.

Wachsmuth, Charles, and Springer, Frank. The Summit Plates in Blastoids, Crinoids, and Cystids, etc. Pp. 33, with Plates.

Lea, M. Carey, Philadelphia. Papers on the Photo-Chemistry of the Silver Haloids. Pp. 36.

Illinois State Board of Health. Report of Proceedings. July Meeting, 1887. Pp. 15.

Donaldson, Frank, Baltimore, Md. Heredity in Tuberculosis. Pp. 22.

Foster, Michael, and others. The "Journal of Physiology," June, 1887. Cambridge, England. Pp. 90, with Plates. $5 a volume.

Kimball, Lieutenant W. W., and Capps, W. L. Report on the Progress of the Work on the Panama Canal during 1885. Washington: Government Printing-Office. Pp. 38, with Plates.

Withington, Charles F., M. D. Transmission of Infectious Disease through Rags. Pp. 69.

McCall, F., Twin Lakes, Minn. Thoughts on Theological and Scientific Theories. Pp. 36.

Stephenson, F. B., M. D., U. S. Navy. Duty of the State in Public Health. Pp. 11.

Rohé, George H., M. D., Baltimore. Recent Advances in Public Medicine. Pp. 33.

Lewis, H. Carvill, Philadelphia. The Alleged Physical Phenomena of Spiritualism. Pp. 26.

Iowa State Board of Health, Monthly Bulletin, July. Pp. 13.

Halsted, Byron D. Germination of Cucurbitaceous Plants. Pp. 6.

Massachusetts Agricultural Experiment Station. Feeding Experiments with Pigs. Pp. 16.

Mills, T. Wesley, Montreal. Retention and Loss of Hair from a Physiological Standpoint. Pp. 5.

Baker, L. W., Baldwinsville, Mass. Mental Epilepsy. Pp. 22.

Clark, Edward Gordon. The People's Right to Wealth, reduced to $s and Cents. "Monograph Publisher," New York. Pp. 14. 10 cents.

Cope, Edward D. Letters referring to the Completion of the Final Report of the United States Geological Survey of the Territories. Pp. 7.

Schlicht & Field Company, New York. "The Cosmopolitan," July, 1887. Monthly. Pp. 80. 20 cents a number, $2 a year.

Starling Medical College, Columbus, Ohio. Forty first Annual Announcement. Pp. 16.

Forbes, S. A., University of Illinois. The Lake as a Microcosm. Pp. 15.

Fry, Frank R., St. Louis. The Flexibility of the Metacarpophalangeal Joint of the Thumb. Folio.

Martin, H. Newell, and Brooks, W. K. Studies in the Biological Laboratory of Johns Hopkins University. Baltimore: N. Murray. Pp. 58, with Plates. 75 cents a number, $5 per volume.

Shufeldt, R. W., M. D. Observations upon the Habits of Micropus Melanoleucus. Pp. 8, with Plates. On the Visceral Anatomy of Certain Auks. Pp. 5. A Critical Comparison of a Series of Skulls of the Wild and Domesticated Turkeys. Pp. 16.

James, Joseph F., Cincinnati. Account of a Well drilled for Oil or Gas at Oxford, Ohio. Pp. 9.

National Agricultural Exposition at Kansas City, Mo. September to November, 1887. Prospectus. Pp. 48.

Ingersoll, Robert G. Centennial Oration on the Declaration of Independence. Buffalo, N. Y.: H. L. Green. Pp. 22.

Bulletins of the U. S. Geological Survey. No. 34, White, Charles A., M. D. On the Relations of the Laramie Molluscan Fauna. Pp. 54. 10 cents. No. 35. Barus, Carl, and Strouhal, Vincent. Physical Properties of the Iron Carburets. Pp. 62. 10 cents. No. 36. Barus, Carl. Subsidence of Fine Solid Particles in Liquids. Pp. 54. 10 cents. No. 37. Ward, Lester F. Types of the Laramie Flora. Pp. 120, with 57 Plates. 25 cents. No. 38. Diller, J. S. Perodotite of Elliott County, Kentucky. Pp. 31. 5 cents. No. 39. Upham, Warren. The Upper Beaches and Deltas of the Glacial Lake Agassiz. Pp. 84, with Map. 10 cents.

United States Brewers' Association. Twenty-seventh Convention, Baltimore. May, 1887. Proceedings. Pp. 125. A Solution of the Temperance Problem proposed in Switzerland. Pp 15. The Effects of Beer. Pp. 46. Report, State Board of Health of New York, on the Examinations of Beers. Pp. 35. Colonial Liquor Laws. Pp. 262. Real and Imaginary Effects of Intemperance. Pp. 167. Alleged Adulterations of Malt Liquors. Pp. 30. Some Thoughts on the International Temperance Meeting held at Antwerp in September, 1885. Pp 40. The System of High Licenses. Pp. 86. Liquor Laws of the United States. Pp. 256, with Tables. All prepared by G. Thomann.

Cherouny, Henry W., Editor. "Philosophy for the People." Quarterly. Pp. 49. 30 cents.

Wilder, Burt G. The Dipnoan Brain. Pp. 5.

Adams, Herbert B. Notes on the Literature of Charities Baltimore: Johns Hopkins University Agency. Pp. 48. 25 cents.

State Board of Health, Wisconsin. Tenth Report. Madison, Wis. Pp. 250.

Truth-Seeker Company. New York. Nine Demands of the American Secular Union. Sheet. $1.

Drummond, A. T. The Distribution, etc., of British North American Plants. Pp. 12.

Wagner Free Institute of Science. Philadelphia. Transactions. Pp. 134, with Sixteen Plates.

Imperial University, Japan. Journal of the College of Science. Pp. 116, with Plates.

Butler, John S., M. D. The Curability of Insanity, and the Individualized Treatment of the Insane. New York: G. P. Putnam's Sons. Pp. 59. 60 cents.

Ward, Lester F. Synopsis of the Flora of the

Laramie Group. Washington: Government Printing-Office. Pp. 160, with Thirty-five Plates.

Rutgers Scientific School, New Brunswick, N. J. Twenty-second Annual Report, for 1886. Pp. 84.

Hermann, Gustav. The Graphical Statics of Mechanism. New York: D. Van Nostrand. Pp. 158, with Plates.

Barrows, Charles M. Facts and Fictions of Mental Healing. Boston: H. H. Carter & Karrick. Pp. 248.

Spencer, Theodore C. The Struggle for Religious and Political Liberty. New York: The Truth-Seeker Company. Pp. 140. 75 cents.

Maverick National Bank Manual, July 1, 1887. Boston: Wright & Potter Printing Company. Pp. 200.

Board of Education, City of New York. Forty-fifth Annual Report. Pp. 271.

Atkinson, Edward. The Margin of Profits, how it is now divided, etc. New York: G. P. Putnam's Sons. Pp. 123. Paper, 40 cents; bound, 75 cents.

Johonnot, James. Ten Great Events in History. New York: D. Appleton & Co. Pp. 264. 63 cents.

Home Sanitation. A Manual for Housekeepers. Boston: Ticknor & Co. Pp. 80.

Gilman, Arthur. Gilman's Historical Readers. No. 1.—The Discovery and Exploration of America. Pp. 128. 36 cents. No. 2.—The Colonization of America. Pp. 160. 48 cents. No. 3.—The Making of the American Nation. Pp. 192. 60 cents. Chicago: Interstate Publishing Company.

Bancroft, Hubert Howe. History of the Pacific States of North America, Vol. XXXI. Popular Tribunals, Vol. I. San Francisco: The History Company. Pp. 749. $5.

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## POPULAR MISCELLANY.

**Natural History Studies in Boston.**—The reports of the Museum, as given in the "Proceedings" of the Boston Society of Natural History, indicate that considerable progress is being made in the cultivation of a public interest in the objects of the society. The purposes of the "Teachers' School of Science" were greatly aided by the liberal action of the trustee of the Lowell fund in defraying the expense of the lessons and in granting the use of Huntington Hall, and by the kindness of the volunteer agents in distributing and receiving applications and tickets. The superintendent of the public schools also aided the work, and took notice of it in his report. Fifteen lessons were given during the winter of 1883–'84, including five on the "Elements of Chemistry," by Professor Lewis M. Norton; five on "Vegetable Physiology," by Professor George I. Goodale; and five on "Chemical Principles illustrated by Common Minerals," by Professor W. O. Crosby; to all of which 2,798 tickets were given out, 2,295 of them to teachers. In the season of 1884–'85, ten lessons in zoölogy were given by the curator, mainly on a range of subjects specially indicated by the courses of instruction of the schools of Boston, for which 837 tickets were distributed. These were succeeded by a course of ten laboratory lessons in "Elementary Mineralogy," by Professor W. O. Crosby, which were attended by seventy-five persons, occupying the full capacity of the room. The Annisquam Laboratory has proved more useful, and its instruction has been more highly appreciated, than had been anticipated, and "a very decided revival in the number and quality of the attendance" is mentioned. Reliance is placed on the study of natural science in the public schools and in the Massachusetts Institute of Technology for assistance in keeping up the interest in this enterprise. In arranging the plan of the school, the director assumed that all persons admitted would be capable of conducting their own work, whereas they very rarely proved to be so; and that all the students would be able to realize that being taught how to do one's own work was more valuable than the mere information gained. As a rule, the ablest students acknowledged the benefit of the mode of work, and, after a short experience, expressed great satisfaction and gratitude.

**Aztec Ikonographic Writing.**—Ikonomatic is a term which Dr. Brinton applies, in distinction from ikonographic and alphabetic, to a kind of rebus-writing, in which a figure or picture refers to the name of an object, the sound of which is applied to the name of some other object or idea. It is exemplified in certain of the hieroglyphic inscriptions of Egypt, and in some of the heraldic devices of the middle ages. It was freely used in the ancient Mexican inscriptions, in which the suggestion of the figure itself, the relative position of the objects, and the colors used, all may have had, and evidently often did have, phonetic significance. The Aztec writing also contained determinatives, such in principle as are frequent in the Egyptian inscriptions, and numerous ideograms. Sometimes the ideogram was associated with the phonetic symbol, and acted as a sort of determinative to it. Besides employing it in proper names, the Aztecs composed in the ikonomatic system words, sentences, and treatises on various subjects. In proportion as it was applied to connected and lengthy compositions, its processes became more recondite, curious, and difficult of interpretation—impossible without considerable knowledge of the spoken language The study of it has, however, been pursued with what Dr. Brinton calls marked and gratifying results, by Mrs. Zelie Nuttall Pinart. This lady, the author says, "has unraveled a number of the pages of the 'Vienna Codex,' and several of the monolithic inscriptions which have been handed down from ancient Mexico. With commendable caution she has refrained from publishing her results until they could be presented supported by such proofs that they can not be questioned; but from a personal examination of them I do not hesitate to say that they will be found to come up to the highest standard of scientific requirements."

**An Incident in School Discipline.**—An instructive incident in the administration of school discipline is related by T. C. Karns, in the "Southwestern Journal of Education." The subject was a boy naturally of good impulses, but who had conceived the idea of the existence of antagonism between teacher and pupil. It was agreed that he must be whipped for a serious breach of the order of the school which he had committed. He assuming a defiant attitude toward the teacher, the latter replied to him: "No; if you do not comply willingly, I will not whip you, Sam. There will be no contest between us; but, as you will not be subject to the rules which you agreed to obey when you entered school, you can not stay here longer, and I will write a note explaining all to your mother, which you will please to carry to her." This having been said pleasantly, the teacher sat down to write the note, while the boy waited and reflected. The note made a pleasant mention of Sam's good traits, and expressed regret that his failure to comply with some of the regulations of the school made it necessary to dismiss him. The boy was given it, but hesitated to start away, and said, "I am not going to take this to my mother." The teacher answered that if Sam did not want to take the note, he would send it by a carrier, or drop it in the mail, "But I thought you would prefer to carry it in person, and have something to say in your own behalf." Sam made another effort to start, but appeared to be overcome, and, walking up to the teacher, extended his hand, and said, "Whip me—I can't stand this!" The teacher, of course, would not whip him then, nor would he send the note to the boy's mother, but saying that all that had passed should rest between the two, added, "Only be sure that your conduct is all right for the future." "New light," says the teacher, "seemed to dawn upon Sam. This was a new experience for him. I nodded assent, and he passed out again. It was but a moment, when a head was again protruded at the door, and a choking voice uttered the words, 'Much obliged to you.' I never had any more trouble with Sam." The boy was conquered by just and manly treatment. When the spirit of antagonism had been removed, he had nothing left to stand upon, and his self-respect forced him to be a man in return.

**Ptomaines in Stale Milk.**—The evidence of the development of ptomaines in stale milk accumulates, and it is becoming more and more probable that the instances of poison-sickness which occasionally occur after partaking certain creams, or ices, or cheeses, may be traced to this source. Dr. R. H. Firth reports, upon the examination of some milk to which his attention was called as having occasioned sickness, that after the evaporation of an ethereal extract from the filtrate, a moist, semi-crystallized residue was left. It had a "mawkish, sickly odor," and a strongly pungent taste when put on the tongue. Taking some of it carefully himself, he was soon afterward conscious of nausea and dryness of the fauces, and then of headache. He gave all the remaining residue to a dog. The dog was within fifteen minutes purging, vomiting, and obviously ill. It gradually recovered, but, being afterward killed, its stomach and intestines were found to contain a serous and frothy fluid, but quite free of congestion or inflammatory action. Fresh milk when tested did not yield any substance having a toxic action. But of stoppered bottles of milk set away for "cultivation," at a temperature of 80° Fahr., those opened after about ten weeks, yielded a white acicular crystalline substance having the same odor and taste as that found in the original suspected milk. The effects of this substance on the experimenter and on dogs and cats were the same. For this ptomaine, the author suggests the name of lactotoxine.

**Myths and Theories about Earthquakes.**—Professor Milne, in a lecture before the Scientific Society of Tokio, Japan, classified the theories that have been enunciated respecting the cause of earthquakes as unscientific, *quasi*-scientific, and scientific. Having mentioned as among the unscientific theories those which ascribed the convulsions to dispensations of Providence, the lecturer described some of the myths which attribute them to a creature living underground. In Japan it is an "earthquake-insect," covered with scales and having eight legs, or a great fish having a rock on his head which helped to keep him quiet. In Mongolia the animal was said to be a frog, in India the world-bearing elephant, in Celebes a world-supporting hog, in North America a tortoise. In Siberia there was a myth connected with the great bones fo nd there, that these were the remains of animals that lived underground, the trampling of which made the ground shake. In Kamchatka the legend was connected with a god that went out hunting with his dogs; when the latter stopped to scratch themselves, their movements produced earthquakes. In Scandinavian mythology, Loki, having killed his brother Baldwin, was bound to a rock, face upward, so that the poison of a serpent should drop on his face. Loki's wife, however, intercepted the poison in a vessel, and it was only when she had to go away to empty the dish that a few drops reached him and caused him to writhe and shake the earth. The *quasi*-scientific theories endeavored to account for earthquakes as part of the ordinary operations of Nature, as that they were produced by the action of wind confined inside of the earth. The theory of electrical discharges was advocated in 1760 by Dr. Stukely, and by Percival and Priestley, and is held in California at the present day, where it is believed that the network of rails is a protection to the State against dangerous accumulations of electricity. The lecturer thought that the electric phenomena which sometimes attended earthquakes were their consequences, not their causes. The chemical theories were very strong in Europe up to the beginning of the present century. It was only in 1760 that Dr. Mitchell first threw out the theory that earthquakes were connected in some way with volcanoes, and attributed them to the penetration of strata by steam. Professor Rogers, at about the same time, in America, endeavored to show that it was not steam, but really lava, that ran along underneath the ground, causing it to rise and fall, thus producing an earthquake.

**Weathercocks.**—Why, asks Mr. J. A. Farrer, in an essay on "Animal Lore," should cocks figure on the tops of steeples? Christians connect the custom with the reproach the cock once conveyed to St. Peter. But the cock used to be placed on the tops of sacred trees long before it was transferred to church-steeples, and in North Germany it still stands upon the May-poles. It was partly a watchman and partly a weather-prophet, and by its crowing it could disperse evil spirits and all approaching calamities. Its life was sacred in India and Persia, and Cicero speaks of the ancients regarding the killing of a cock as a crime equal in blackness to the suffocation of a father. Our weathercocks are doubtless the survivals of these old ideas, though the solar mythologists trace all these things to the use of the domestic fowls as obvious personifications of the sun. One can scarcely conceive anything more absurd; and it would be interesting to know how on solar principles would be explained the Tyrolese custom of not letting a black hen live for seven years, lest she should then lay an egg, out of which might issue a dragon destined to live a hundred years.

**School-room Lights.**—Dr. Willoughby, of the English Society of Medical Officers of Health, in a paper on "School Lighting," maintains that as long as the light from the left is the stronger, so that the shadow of the hand does not fall on the writing, the objections urged against "cross-lighting" are imaginary; and that while the main source of light should always be on the left, it might be advantageously supplemented by lights of lesser intensity from either side, whereby the total illumination would be increased. In wide rooms the rows of desks on either side should face in opposite directions, so that the nearer and consequently stronger light should always come from the left. No natural light not coming direct from the sky could be sufficient, but whether sky-light were so or not would depend on the angle of aperture, or arc of the sky visible at any given point, which should never be less than 5°, and the angle of incidence, which should not be less than 25°. In artificial lighting, shades acting also as reflectors are preferable to semi-opaque globes, which involve much loss of light. The two points to be observed in the arrangement of the lighting are the avoidance of shadows and of the direct incidence of the light on the eyes.

**Uses of Birch-Bark.**—Professor Gustav Retzius has a chapter, in his sketches of Finland, respecting the uses which the Finnish people make of birch-bark. Shoes are made of it. The bark, having been peeled, is cut into strips, rolled up carefully, and put away for future use. When the Finnish peasant wants a pair of new shoes, he takes one of his rolls, cuts it up into strips of suitable width, soaks it in water to soften it, and then weaves it into the form he desires. It is all done very rapidly, a half-hour or less sometimes sufficing for the whole work. The shape of the shoes varies according to the use they are to be put to. If they are for swamps, he makes them into low-cut slippers or sandals. With these he can walk through the moors without wounding his feet on the sharp sticks, while the water flows in and out freely. Another shape is that of regular shoes with high sides, and toes either run out to a point or cut short off. They are made wider than is necessary to accommodate the foot, so that in cold weather they may be stuffed with hay and the foot wrapped with bandages. A third form is a kind of half-boot. All the three forms are still used in much of the interior of the country during work in the fields, the swamps, the woods, and the house, especially among the poorer people. These bark shoes have in fact many advantages. They are very cheap, costing really nothing; they are strong and durable, and warm, with the help of hay and wrappings. In moist ground they let the water in and out without softening, and, by changing the hay or wrappings, are easily dried. Many other uses are found for birch-bark. The sheath in which the peasant carries his inseparable knife is made of it. It is woven into pockets or bags of various sizes, which are used all over Finland. The larger of these form a satchel with a flap which may be turned over and close the bag. Wherever one may travel in Finland, he will meet children, women, and men with these satchels. The peasant carries his dinner in one, and with the satchel on his back, birch-bark shoes on his feet, and his tools in his hands, goes out equipped for his day's work. These satchels also take the place of baskets. Birch-bark is made into salt-tubs, cords and lines, brushes for washing out wooden vessels, boxes, sieves and tubs, and many other articles for which we use wood or basket material.

**The Microscope in Geology.**—President T. G. Bonney, of the Geological Section of the British Association, spoke on the "Application of Microscopic Analysis to discovering the Physical Geography of by-gone Ages." The microscope furnishes us with an instrument of precision, by means of which we can learn the more minute mineral composition and structural peculiarities of rocks, can recognize fragments, and sometimes even determine the source of the smaller constituents in a composite clastic rock. Thus, by its aid, we may be able, in many cases, to substitute a demonstration for a conjecture. The speaker described the materials of the coarser fragmental rocks of Great Britain, and laid down the following principles of interpretation: 1. Pebbles indicate the action either of waves of the sea, or of strong currents, marine or fluviatile. 2. The zone in the sea over which the manufacture of pebbles can be carried on is seldom wider than from the high-tide line to a depth of within twenty feet below low-water mark. It is, therefore, probable that a thick and very widely-extended pebble-bed is not the result of wave-action. 3. The movement of the deep waters of the sea, as a rule, is so slight that only the very finest sediment can be affected by it. The instances where great currents may transport pebbles and sand are exceptional, and confined to rather shallower water. The larger coast currents may, however, transport mud to considerable distances, but in directions parallel with the main trend of the shores. 4. Except where very large rivers discharge their water into the ocean, or in some special cases of 3, sediment is deposited comparatively near the shores of continents, according to the Challenger's sounding in no important amounts farther away than one hundred and fifty miles. 5. Thus rain and rivers are generally more important agents of denudation and transportation than the sea. 6. The coarser materials of rocks are capable of being transported by streams to a considerable distance without serious diminution of volume. 7. Deposits of gravel and coarse sand, of considerable vertical thickness and great vertical extension, are more likely to indicate the immediate action of a river than of a marine current.

**The Happiness of Animals.**—It is hard to conceive that the question, "Are animals happy?" should be seriously asked by any one who is acquainted with animals, or comprehends what constitutes happiness. Yet there are some writers—for scientific journals, too—who treat the question as open to debate, or are even inclined to answer it in the negative. Mr. Briggs Carlill, who thinks it worth while to take it up in the "Nineteenth Century," has no difficulty in giving a decidedly affirmative answer. Two general considerations, he says, precede all arguments on the subject, and may be disposed of in the beginning. They are, that animals do not commit suicide, though they might, and know how to do it; and that they increase and multiply—which they would not do were their condition miserable. Animals are, it is true, deprived of man's mental pleasures, which are the highest ones to those who appreciate them; but then they are, in partial compensation, spared from worry. With man, the local pleasures, or those of sensation and convenience, largely preponderate over mental pleasures, while of his pains, mental troubles constitute much the largest part. Suppose the mental powers gradually to diminish, while the bodily powers remain unimpaired till the mind no longer troubles itself about unseen things; we shall then approach the constitution of the higher mammalia. All animals enjoy the taking in of food. More highly developed ones have another opening for pleasure in the faculty of discovering sources of food; animals which catch their prey, the additional excitement of pursuit and capture; ruminants enjoy the chewing of the cud. Exercise counts for a good deal in the youth of all animals, and continues throughout life in the majority to afford enjoyment of the keenest description, while many of them have the delight that the power of swift motion gives. "Constantly throughout the animal world we notice that delight in the use of muscle and limb which in man scarcely survives his majority, but which in them lasts far into maturity. We are accustomed unconsciously to recognize their prerogative in this respect when we apply the phrase 'animal spirits' to a boy who is full of life and energy, and who enjoys a run over the hills on a breezy day." All animals, also, enjoy to a full extent the pleasures connected with the perpetuation of their species and the care of their young—the latter of which are akin to some of man's mental pleasures. What is there to set off against these pleasures which accompany alike the activities preservative of individual life and those preservative of the species? Principally, these four things—famine, exposure to weather, bodily injury, and violent death; things not altogether unknown to man. But the suffering in all these cases is of short duration, and is usually tempered by circumstances in the animal's age, condition, or power of adaptation, while the keenest element of it—the thinking about it—is wholly absent; so that its intensity is so much less in animals than in man that, even if the individual instances of it are more frequent, the balance of advantage would probably remain with the brutes. The author's conclusion, therefore, is, that "so far as bodily pains and pleasures are concerned, if in humanity there be a surplus of pleasure over pain, there is in brutes a still greater surplus; if in humanity there be anything like an equality between pleasure and pain, there is in brutes a large preponderance of pleasure; if in humanity pain predominate, then in brutes the proportion should be reversed."

**Air in Dwellings and School-Rooms.**—In the experiments of Professor Carnelly on the air of dwellings and schools, and its relations to disease, a distinct increase of impurities was detected in the air of the close parts, as compared with the open spaces, of such towns as Perth and Dundee. As between different classes of dwelling-houses, one-, two-, and four-roomed dwellings, the average length of life in the one-roomed house was only twenty years, while in the better-class houses it was forty years. Hence, persons born and living in a one-roomed house have a chance of living only half as long as those born and living in a four-roomed house. This depends naturally to a considerable extent on other causes than impure air-supply. The best results in the relation of atmospheric purity to cubic space were noticed when the allowance was one thousand cubic feet for each person. The result, owing to stagnation, was not so good in larger rooms. Of sixty-eight school rooms in Dundee, twenty-six were mechanically ventilated, and the others were ventilated by means of windows. The advantage was found to be decidedly on the side of mechanical ventilation, which not only materially improves the quality of the air, but also causes less reduction in its temperature. The air was less pure in boys' schools than in girls' schools. Cleanliness of person had a comparatively small influence on the number of micro-organisms, but cleanliness of dwelling-rooms and schools had a most important effect. Hence, the air of new school-rooms is distinctly better than that of older buildings. The author suggests that the evil said to be due to overpressure in schools is, in many cases, due to imperfect ventilation.

**How Lampreys build their Nests.**—In a paper on "Lampreys of Cayuga Lake," read at the American Association, Messrs. S. H. Gage and S. E. Meek held that the study of the specific characters of these animals had convinced them of the specific identity of the sea and Cayuga Lake lamprey, and that the alleged specific differences are but seasonal and individual variations. In the spring, May and June, the lampreys ascend the largest of the streams flowing into the lake for the purpose of spawning. They build nests of stones in the bottom of the stream, usually just above declivities where the water breaks in ripples. In forming the nests the stones are removed, forming a circular or oval place, the diameter of which is a little more than the length of the lamprey. In removing the stone the lamprey fastens its suctorial mouth to the stones, wriggling strongly until the stone is loose. It then raises it free and floats down with the current to the lower edge of the nest, where the stone is dropped. In this way all of the stones are removed for a depth of from ten to twenty centimetres. As nearly all of the stones are piled up at the lower edge of the nest, that is the highest. The current carries down into the nest fine gravel, partly filling it. When the eggs are laid, the sand is stirred up, and the eggs being heavier than water sink with the sand and are covered by it. Lampreys if placed in an aquarium with other fishes will attach themselves to them and produce wounds.

**Value of M. Pasteur's Hydrophobia Inoculations.**—A committee appointed by the British Local Government Board to inquire into M. Pasteur's method of treatment of hydrophobia made a report in June, 1887. The committee consisted of Messrs. James Paget, T. Lauder Brunton, George Fleming, Joseph Lister, Richard Quain, Sir Henry Roscoe, and J. Burdon-Sanderson—men whose judgments in the premises can be relied upon if those of any men can. The committee visited Paris; made special examinations of ninety of M. Pasteur's earliest cases who were within easy reach of the capital; and through its secretary, Mr. Victor Horsley, made careful experiments on the effects of M. Pasteur's inoculations on the lower animals. The conclusion of the committee is expressed, after relating its observations, in the words: "From the evidence of all these facts, we think it certain that the inoculations practiced by M. Pasteur on persons bitten by rabid animals have prevented the occurrence of hydrophobia in a large number of those who, if they had not been so inoculated, would have died of that disease. And we believe that the value of this discovery will be found much greater than can be estimated by its present utility, for it shows that it may become possible to avert by inoculation, even after infection, other diseases than hydrophobia. . . . His researches have also added very largely to the knowledge of the pathology of hydrophobia, and have supplied what is of the highest practical value, namely, a sure means of determining whether an animal, which has died under suspicion of rabies, was really affected with that disease or not." The answer to the question whether M. Pasteur's treatment can be submitted to without danger to health or life, must be qualified accordingly as the question is applied to the ordinary method, concerning the entire safety of which no reason of doubt has yet appeared; or to the intensive method which has been applied only to cases deemed especially urgent. In many of the urgent cases the intensive method is believed to have been more efficacious than the ordinary method would have been. In other cases deaths have occurred under conditions which have suggested that they were due to the inoculations rather than to the infection from the rabid animal. But in these cases it is open to doubt whether the effect of the inoculation may not have been to modify the form of the rabies already nascent, into "paralytic rabies," rather than of itself to produce it. In order to reduce risks, M. Pasteur has greatly modified his intensive treatment, and limited its application to the most urgent cases.

## NOTES.

The steamers of the new American "Arrow Line" are to be constructed upon a new principle, and with a view to an estimated speed sufficient to make the voyage between New York and Liverpool in a little more than four days. The Pocahontas will be 540 feet long, will be provided with 1,060 water-tight compartments, 500 of which are to be below the water-line, and will have 20 boilers with engines of 27,986 horse-power and capable of giving a speed of 22 knots an hour.

Professor Asaph Hall has determined the parallax of Aldebaran at 0·102″, with a probable error of 0·0296.

The sixtieth meeting of the German Association of Naturalists will be held at Wiesbaden, September 18th to 24th. A number of new scientific instruments and preparations will be shown.

An unusually large number of foreign men of science will, it is expected, be present at the forthcoming meeting of the British Association in Manchester. Among the Americans are Cleveland Abbe, J. R. Eastman, of the United States Naval Observatory; and William Libbey, Malcolm McNeill, and C. A. Young, of Princeton College, in Section A; F. W. Clarke, J. W. Langley, and J. W. Mallet, in Section B; Asa Gray, C. S. Minot, and E. S. Morse, in Section D; Dana Horton and Judge Mackay, in Section F; and Thomas Egleston and J. B. Francis, in Section G.

Dr. E. A. A. Grange, of the Agricultural College of Michigan, describes a disease in the foot of the horse, frequently occurring in the summer season, which he calls *laminitis*, but which is often manifested as what is called chest-founder, from the position which it causes the horse to take, suggesting an affection of the chest. The disease is really an inflammation of the sensitive laminæ of the foot, sometimes involving neighboring structures, and may be compared with toothache. It may be caused by overheating and sudden cooling, overworking, overfeeding, or too long and close confinement in the stall. It is manifested by attitudes indicating pain, by irregularities in breathing, twitching movements, etc. The treatment materially depends upon the cause in the particular case, and is both general and local.

The British Inspectors of Explosives report for 1886 the continued satisfactory operation of the Explosives Act of 1875. Only one loss of life was returned in legitimate manufacture, as against an average of over eight in the eight years previous. Mention is made in the report of 143 accidents having occurred during the year, whereby 40 persons were killed and 136 injured. The averages for the previous nine years were 38 killed and 98 injured.

Mr. Alfred Carpenter, of the Marine Survey office, Bombay, has observed Macacus monkeys on the island off South Burmah opening oysters with a stone. They bring the stones from high-water mark down to low-water, selecting such stones as they can easily grasp. They effect the opening by striking the base of the upper valve until it dislocates and breaks up. They then extract the oyster with the finger and thumb, occasionally putting the mouth straight to the broken shell. The way they have chosen is the easiest way to open the shell.

The "Technology Quarterly" has been started at the Massachusetts Institute of Technology. It is published by a board of editors chosen from the senior and junior classes, who are intended to represent all the departments of the Institute.

Dr. T. Langdon Down, inquiring into the causes of idiocy, has found that intemperance of parents is one of the most considerable factors in producing the affection. His view is confirmed by some French and German investigators, one of whom, Dr. Delasiauve, has said that in the village of Carême, whose riches were in its vineyards, ten years' comparative sobriety, enforced by vine-disease, had a sensible effect in diminishing the cases of idiocy. Nervous constitution and consumption exercise important influence. Of the professions, lawyers furnish the smallest proportion of idiots, while they are credited with the procreation of a relatively very large number of men of eminence. With the clergy, these proportions are more than reversed. The influence of consanguineous marriage, *per se*, is insignificant, if it exists.

The French Association for the Advancement of Science will meet in Toulouse, September 22d to 29th.

Bottles for holding spirits and acids are now made of paper. The glued paper is rolled by machinery into such a tube as is required, and the tube is cut up into suitable lengths. The tops and bottoms, of wood or paper, are cemented in, and necks are added when required. The interiors of the bottles are then lined with a heated fluid composition that sets hard and will resist acids and spirits. The bottles are practically unbreakable, have a minimum of weight, and require no packing material in transit. The manufacture is said to be carried on extensively in Chicago, and has been introduced into England.

Mr. Nordenskiöld some time ago received an account from Don Carlos Stolp, of San Fernando, Chili, of his observations of the "red sunsets" of 1883-'84, from a point on the Andes about fifteen thousand feet above the sea; and afterward Señor Stolp sent some specimens of an atmospheric dust which he had observed at the same time. Analysis of this dust showed that it had no relation to volcanic dust, but that it was of the kind regarded as cosmic dust—containing the iron, nickel, phosphoric acid, and magnesia constituents characteristic of the cosmic deposits. There is, however, no evidence that this dust was connected with the red light.

Mr. Ernest Hart, of the Smoke Abatement Institute, fears that London will always suffer from fogs, because it is placed in a river valley, on a clay soil, and is bordered on the Essex side by low-lying lands very imperfectly drained, and on the north side by the Harrow Weald. The fogs generated—the results of damp exhalations—are greatly aggravated by the parks, most of which require draining. But if the smoke is got rid of, the fogs will be much less dense.

An English National Association for the Promotion of Technical Education has been formed. The Marquis of Hartington is its president, and several lords, Professor Huxley, Sir John Lubbock, Mr. Mundella, Sir Lyon Playfair, Professor Stuart, and Professor Tyndall, are among its vice-presidents.

Photographs of the sun were taken at Greenwich Observatory on 199 days during 1886, while photographs from India filled in the gaps for 164 days; so that the record of observations is complete for all but two days. The area of sun-spots and faculæ has continued to decline during 1886 and 1887. There were 61 days in 1886, and from October to April 17th last, 73 days on which no spots appeared.

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## OBITUARY NOTES.

Charles Rau, one of the curaters of the Smithsonian Institution, died in Washington, July 28th, at about seventy years of age. He was invited by Professor Henry about forty years ago to come to the United States and take a position in the Smithsonian Institution. He was the author of archæological books, and of numerous special articles in his chosen study.

Dr. Moritz Wagner, professor in the University of Munich, a distinguished traveler and scientific writer, died May 31st.

The death of M. Issartier, a French senator and mayor, formerly an eminent medical man, is reported. M. Issartier had long given up the practice of medicine, and had devoted himself to horticulture and scientific agriculture. He published a treatise on the cultivation of fruit-trees, and a course in agriculture.

Ivan Polyakoff, who died recently at St. Petersburg, at about forty years of age, was regarded as one of the most promising Russian men of science. His particular field was in botany and zoölogy. His earlier papers were published in the "Irkutsk Gazette." He was engaged upon expeditions from the Lena gold-washings to Transbaikalia, in the Olonetz region, the middle Volga, the lower Obi region and Saghalien, and the Pacific littoral. He was attacked with his final illness on his return from the last journey. He was the author of the accepted description of Prjevalsky's horse, "Equus Prjevalski."

CARL WILHELM SCHEELE.

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# WHAT IS EVOLUTION?*

By Professor JOSEPH LE CONTE.

EVERY one is familiar with the main facts connected with the development of an egg. We all know that it begins as a microscopic germ-cell, then grows into an egg, then organizes into a chick, and finally grows into a cock; and that the whole process follows some general, well-recognized law. Now, this process is evolution. It is more—it is *the* type of all evolution. It is that from which we get our idea of evolution, and without which there would be no such word. Whenever and wherever we find a process of change more or less resembling this, and following laws similar to those determining the development of an egg, we call it evolution.

Evolution as a *process* is not confined to one thing, the egg, nor as a doctrine is it confined to one department of science—biology. The process pervades the whole universe, and the doctrine concerns alike every department of science—yea, every department of human thought. It is literally one half of all science. Therefore, its truth or falseness, its acceptance or rejection, is no trifling matter, affecting only one small corner of the thought-realm. On the contrary, it affects profoundly the foundations of philosophy, and therefore the whole domain of thought. It determines the whole attitude of the mind toward Nature and God.

I have said evolution constitutes one half of all science. This may seem to some a startling proposition. I stop to make it good.

Every system of correlated parts may be studied from two points of view, which give rise to two departments of science, one of which —and the greater and more complex—is evolution. The one concerns changes within the system by action and reaction between the parts,

* From advance sheets of Professor Le Conte's work on "Evolution and its Relation to Religious Thought," in preparation by D. Appleton & Co.

producing equilibrium and stability; the other concerns the progressive movement of the system, as a whole, to higher and higher conditions—the movement of the point of equilibrium itself, by constant slight disturbance and readjustment of parts on a higher plane, with more complex inter-relations. The one concerns the laws of sustentation of the system, the other the laws of evolution. The one concerns things as they are, the other the process by which they become so. Now, Nature as a whole is such a system of correlated parts. Every department and sub-department of Nature, whether it be the solar system or the earth, or the organic kingdom, or human society, or the human body, is such a system of correlated parts, and is therefore subject to evolution. We can best make this thought clear by examples:

1. Take, then, the *human body*. This complex and beautiful system of correlated and nicely-adjusted parts may be studied in a state of maturity and equilibrium, in which all the organs and functions by action and reaction co-operate to produce perfect stability, health, and physical happiness. This study is physiology. Or else the same may be studied in a state of progressive change. Now, we perceive that the stability is never perfect—the point of equilibrium is ever moving. By the ever-changing number and relative power of the co-operating parts the equilibrium is ever being disturbed, only to be readjusted on a higher plane, with still more beautiful and complex inter-relations. This is growth, development, evolution. Its study is called embryology. 2. Take another example—*the solar system*. We may study sun, planets, and satellites in their mutual actions and reactions, co-operating to produce perfect equilibrium, stability, beautiful order, and musical harmony. This is the ideal of physical astronomy as embodied in Laplace's "Mécanique Céleste." Or we may study the same in its origin and progressive change. Now, we perceive that equilibrium and stability are never absolutely perfect, but, on the contrary, there is continual disturbance with readjustment on a higher plane—continual introduction of infinitesimal discord, only to enhance the grandeur and complexity of the harmonic relations. This is the nebular hypothesis—the theory of the development of the solar system. It is cosmogony; it is evolution. 3. Again: *society* may be studied in the mutual play of all its social functions so adjusted as to produce social equilibrium, happiness, prosperity, and good government. This is social statics. But equilibrium and stability are never perfect. Permanent social equilibrium would be social stagnation and decay. Therefore, we must study society also in its onward movement—the equilibrium ever disturbed, only to be readjusted on a higher plane with more and more complexly inter-related parts. This is dynamics—social progress. It is evolution. 4. Again: the *earth*, as a whole, may be studied in its present forms, and the mutual action of all its parts—lands and seas, mountains and valleys, rivers, gulfs, and bays, currents of air and ocean—and the manner in which all these, by action

and reaction, co-operate to produce climates and physical conditions such as we now find them. This is physical geography. Or, we may study the earth in its gradual progress toward its present condition—the changes which have taken place in all these parts, and consequent changes in climate ; in a word, the gradual process of becoming what it now is. This is physical geology—it is evolution. 5. Lastly, we may study the whole *organic kingdom* in its entirety as we now find it—the mutual relation of different classes, orders, genera, and species to each other and to external conditions, and the action and reaction of these in the struggle for life—the geographical distribution of species and their relation to climate and other physical conditions, the whole constituting a complexly adjusted and permanent equilibrium. This is a science of great importance, but one not yet distinctly conceived, much less named.* Or, we may study the same in its gradual progressive approach, throughout all geological times, toward the present condition of things, by continual changes in the parts, and therefore disturbance of equilibrium and readjustment on a higher plane with more complex inter-relations. This is development of the organic kingdom. In the popular mind it is, *par excellence*, evolution.

We might multiply examples without limit. There are the same two points of view on all subjects. As already said, in the one we are concerned with things as they are ; in the other, with the process by which they became so. This "law of becoming" in all things—this universal law of progressive inter-connected change—may be called the law of continuity. We all recognize the universal relation of things, gravitative or other, in space. This asserts the universal causal relation of things in *time*. This is the universal law of evolution.

But it has so happened that in the popular mind the term evolution is mostly confined to the development of the organic kingdom, or the law of continuity as applied to this department of Nature. The reason of this is that this department was the last to acknowledge the supremacy of this law ; this is the domain in which the advocates of supernaturalism in the realm of Nature had made their last stand. But it is wholly unphilosophical thus to limit the term. If there be any evolution, *par excellence*, it is evolution of the individual or embryonic development. This is the clearest, the most familiar, and most easily understood, and therefore the type of evolution. We first take our idea of evolution from this form, and then extend it to other forms of continuous change following a similar law. But, since the popular mind limits the term to development of the organic kingdom, and since, moreover, this is now the battle-ground between the advocates of continuity and discontinuity—of naturalism and supernaturalism in the *realm of Nature*—what we shall say will have reference chiefly to this department, though we shall illustrate freely by reference to other forms of evolution.

* The term *chorology*, used by Haeckel, nearly covers the ground.

Definition of Evolution.—Evolution is (I) continuous *progressive change*, (II) *according to certain laws*, (III) and by means of *resident forces*. It may doubtless be defined in other and perhaps better terms, but this suits our purposes best. Embryonic development is the type of evolution. It will be admitted that this definition is completely realized in this process. The change here is certainly continuously progressive; it is according to certain well-ascertained laws; it is by forces (vital forces) resident in the egg itself. Is, then, the process of change in the organic kingdom throughout geologic times like this? Does it correspond to the definition given above? Does it also deserve the name of evolution? We shall see.

I. Every individual animal body—say man's—has become what it now is by a gradual process. Commencing as a microscopic spherule of living but apparently unorganized protoplasm, it gradually added cell to cell, tissue to tissue, organ to organ, and function to function; thus becoming more and more complex in the mutual action of its correlated parts, as it passed successively through the stages of germ, egg, embryo, and infant, to maturity. This ascending series of genetically connected stages is called the embryonic or *Ontogenic* series.*

There is another series the terms of which are coexistent, and which, therefore, is not in any sense a genetic or development series, but which it is important to mention, because to some degree similar to and illustrative of the last. Commencing with the lowest unicelled microscopic organisms, and passing up to the animal scale, *as it now exists*, we find a series of forms similar, though not identical, with the last. Here, again, we find cell added to cell, tissue to tissue, organ to organ, and function to function, the animal body becoming more and more complex in structure, in the mutual action of its correlated parts, and the mutual action with the environment, until we reach the highest complexity of structure and of internal and external relations only in the highest animals. This ascending series may be called the natural history series; or the classification or *Taxonomic series*.† The terms of this series are, of course, not genetically connected; at least, not directly so connected. In what way they are connected, and how the series comes to be similar to the last, we shall see by-and-by.

Finally, there is still a third series, the grandest and most fundamental of all, but only recently recognized, and therefore still imperfectly known. Commencing with the earliest organisms, the very dawn of life, in the very lowest rocks, and passing onward and upward through Eozoic, Palæozoic, Mesozoic, Cenozoic, to the Psychozoic or present time, we again find first the lowest forms, and then successively forms more and more complex in structure, in the interaction of correlated parts and in interaction with the environment, until we reach the most complex internal and external relations, and therefore

* *Ontos-gennao* (individual-making, or genesis of the individual).

† *Taxis, nomos* (relating to science of arrangement).

the highest structure only in the present time.* This series we will call the geological or *phylogenic* series.† According to the evolution theory, the terms of *this* series also are genetically connected. It is, therefore, an evolution series. Furthermore, it is the most fundamental of the three series, because it is the *cause* of the other two. The Ontogenic series is like it because it is a brief recapitulation, through heredity, as it were from memory, of its main points. The Taxonomic series is like it because the *rate* of advance along different lines was different in every degree, and therefore every stage of the advance is still represented in a general way among existing forms. Some of these points will be explained more fully in connection with the evidences of the truth of evolution.

It will be admitted, then, that we find *progressive change* in organic forms throughout geological times. This is the first point in the definition of evolution.

II. We have shown continuously progressive change in organic forms during the whole geologic history of the earth, similar in a general way to that observed in embryonic development. We wish now to show that the *laws of change* are similar in the two cases. What, then, are the laws of succession of organic forms in geologic times? I have been accustomed to formulate them thus: *a.* The law of differentiation; *b.* The law of progress of the whole; *c.* The law of cyclical movement.‡ We will take up these and explain them successively, and then, afterward, show that they are also the laws of embryonic development, and therefore the laws of evolution:

*a.* It is a most significant fact, to which attention was first strongly directed by Louis Agassiz, that the earliest representatives of any group, whether class, order, or family, were not what we would now call typical representatives of that group; but, on the contrary, they were, in a wonderful degree, connecting links; that is, that along with their distinctive classic, ordinal, or family characters they possessed also other characters which connected them closely with other classes, orders, or families, now widely distinct, without connecting links or intermediate forms. For example: The earliest vertebrates were fishes, but not typical fishes. On the contrary, they were fishes so closely conected by many characters with amphibian reptiles, that we hardly know whether to call some of them reptilian fishes, or fish-like reptiles. From these, as from a common vertebrate stem, were afterward separated, by slow changes from generation to generation, in two directions, the typical fishes and the true reptiles. So, also, to take another example, the first birds were far different from typical

* This statement is general; it will be modified hereafter.

† *Phule-gennao* (kind-making); genesis of the race.

‡ This formulation of the laws of organic succession was given by me in 1860, before I knew anything of either Darwin's or Spencer's evolution. They were my own mode of formulating Agassiz's views.

birds as we now know them. They were, on the contrary, birds so reptilian in character, that there is still some doubt whether bird-characters or reptilian characters predominate in the mixture, and therefore whether they ought to be called reptilian birds or bird-like reptiles. From this common stem, the more specialized modern reptiles branched off in one direction and typical birds in another, and intermediate forms became extinct; until, *now*, the two classes stand widely apart, without apparent genetic connection. This subject will be more fully treated hereafter, and other examples given. These two will be sufficient now to make the idea clear.

Such early forms combining the characters of two or more groups, now widely separated, were called by Agassiz *connecting* types, *combining* types, *synthetic* types, and sometimes *prophetic* types; by Dana, *comprehensive* types; and by Huxley, *generalized* types. They are most usually known now as *generalized* types, and their widely-separated outcomes *specialized* types. Thus, in general, we may say that the widely-separated groups of the present day, when traced back in geological times, approach one another more and more until they finally unite to form common stems, and these in their turn unite to form a common trunk. From such a common trunk, by successive branching and rebranching, each branch taking a different direction, and all growing wider and wider apart (differentiation), have been gradually generated all the diversified forms which we see at the present day. The last leafy ramifications—flower-bearing and fruit-bearing—of this tree of life, are the fauna and flora of the present epoch. The law might be called the law of ramification, of specialization of the parts, and diversification of the whole.

*b.* Many imagine that progress is the one law of evolution; in fact, that evolution and progress are coextensive and convertible terms. They imagine that in evolution the movement must be upward and onward in all parts; that degeneration is the opposite of evolution. This is far from the truth. There is, doubtless, in evolution, progress to higher and higher planes; but not along every line, nor in every part: for this would be contrary to the law of differentiation. It is only progress of the whole organic kingdom in its entirety. We can best make this clear by an illustration. A growing tree branches and again branches *in all directions*, some branches going upward, some sidewise, and some downward—anywhere, everywhere, for light and air; but the whole tree grows ever taller in its higher branches, larger in the circumference of its outstretching arms, and more diversified in structure. Even so the tree of life, by the law of differentiation, branches and rebranches continually in all directions—some branches going upward to higher planes (progress), some pushing horizontally, neither rising nor sinking, but only going farther from the generalized origin (specialization); some going downward (degeneration), anywhere, everywhere, for an unoccupied place in the economy of Nature, but the whole tree grows ever higher in its highest parts, grander in its proportions, and more complexly diversified in its structure.

It may be well to pause here a moment to show how this mistaken identification of evolution with progress alone, without modification by the more fundamental laws of differentiation, has given rise to misconceptions in the popular and even in the scientific mind. The biologist is continually met with the question, "Do you mean to say that any one of the invertebrates, such, for instance, as a spider, may eventually, in the course of successive generations, become a vertebrate, or that a dog or a monkey is on the highway to become a man?" By no means. There is but one straight and narrow way to the highest in evolution as in all else, and few there be that have found it—in fact, probably two or three only at every step. The animals mentioned above have diverged from that way. In their ancestral history, they have missed the golden opportunity, if they ever had it. It is easy to go on in the way they have chosen, but impossible to get back on the ascending trunk-line. To compare again with the growing tree, only one straight trunk-line leads upward to the terminal bud. A branch once separated must grow its own way, if it grow at all.

Of the same nature is the mistake of some extreme evolutionists, such as Dr. Bastian and Professor Haeckel, and of nearly all anti-evolutionists, viz., that of imagining that the truth of evolution and that of spontaneous generation must stand or fall together. On the contrary, *if* life did *once* arise spontaneously from any lower forces, physical or chemical, by natural process, *the conditions necessary for so extraordinary a change could hardly be expected to occur but once in the history of the earth.* They are, therefore, *now*, not only unproducible, but unimaginable. Such golden opportunities do not recur. Evolution goes only onward. Therefore, the impossibility of the derivation of life from non-life *now*, is no more an argument against such a derivation *once*, than is the hopelessness of a worm ever becoming a vertebrate *now*, an argument against the derivative origin of vertebrates. Doubtless if life were now extinguished from the face of the earth, it could not again be rekindled by any natural process known to us; but the same is probably true of every step of evolution. If any class—for example, mammals—were now destroyed, it could not be reformed from any other class now living. It would be necessary to go back to the time and condition of the separation of this class from the reptilian stem. Therefore, the falseness of the doctrine of abiogenesis,* so far from being any argument against evolution, is exactly what a true conception of evolution and knowledge of its laws would lead us to expect.

*c.* The movement of evolution has ever been onward and upward, it is true, but not at a uniform rate in the whole, and especially in the parts. On the contrary, it has plainly moved in successive cycles.

* Genesis without previous life—spontaneous generation.

The tide of evolution rose ever higher and higher, without ebb, but it nevertheless came in successive waves, each higher than the preceding, and overborne by the succeeding. These successive cycles are the dynasties or reigns of Agassiz, and ages of Dana; the reign of mollusks, the reign of fishes, of reptiles, of mammals, and finally of *man*. During the early Palæozoic times (Cambrian and Silurian) there were no vertebrates.* But never in the history of the earth were mollusks of greater size, number, and variety of form than then. They were truly the rulers of these early seas. In the absence of competition of still higher animals, they had things all their own way, and therefore grew into a great monopoly of power. In the later Palæozoic (Devonian) fishes were introduced. They increased rapidly in size, number, and variety; and being of higher organization they quickly usurped the empire of the seas, while the mollusca dwindled in size and importance, and sought safety in a less conspicuous position. In the Mesozoic times, reptiles, introduced a little earlier,† finding congenial conditions and an unoccupied place above, rapidly increased in number, variety, and size, until sea and land seemed to have swarmed with them. Never before or since have reptiles existed in such numbers, in such variety of form, or assumed such huge proportions; nor have they ever since been so highly organized as then. They quickly became rulers in every realm of Nature—rulers of the sea, swimming reptiles; rulers of the land, walking reptiles; and rulers of the air, flying reptiles. In the unequal contest, fishes therefore sought safety in subordination. Meanwhile mammals were introduced in the Mesozoic, but small in size, low in type (marsupials), and by no means able to contest the empire with the great reptiles. But in the Cenozoic (Tertiary) the condition apparently becoming favorable for their development, they rapidly increased in number, size, variety, and grade of organization, and quickly overpowered the great reptiles, which almost immediately sank into the subordinate position in which we now find them, and thus found comparative safety. Finally, in the Quaternary, appeared man, contending doubtfully for a while with the great mammals, but soon (in Psychozoic) acquiring mastery through superior intelligence. The huge and dangerous mammals were destroyed and are still being destroyed; the useful animals and plants were preserved and made subservient to his wants; and all things on the face of the earth are being readjusted to the requirements of his rule. In all cases it will be observed that the rulers were such because, by reason of strength, organization, and intelligence, they were fitted to rule. There is always room at the top. To illustrate again by a growing tree: This successive culmination of higher and higher classes may be compared to

* Fishes were first introduced in the later Silurian, but became dominant in the Devonian.

† Amphibians were introduced in the Carboniferous, but true reptiles not until the Permian.

the flowering and fruiting of sucessively higher and higher branches. Each uppermost branch, under the genial heat and light of direct sunshine, received in abundance by reason of position, grew rapidly, flowered and fruited ; but quickly dwindled when overshadowed by still higher branches, which in their turn, monopolized for a time the precious sunshine.

But observe, furthermore : when each ruling class declined in importance, it did not perish, but continued in a subordinate position. Thus, the whole organic kingdom became not only higher and higher in its highest forms, but also more and more complex in its structure and in the interaction of its correlated parts. The whole process and its result is roughly represented in the accompanying diagram (Fig. 1), in

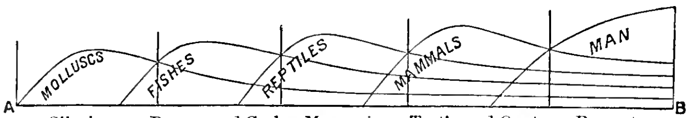

Fig. 1.

which A B represents the course of geological time, and the curve, the rise, culmination, and decline of successive dominant classes.

The above Three Laws are Laws of Evolution.—These three laws we have shown are distinctly recognizable in the succession of organic forms in the geological history of the earth. They are, therefore, undoubtedly the *general laws of succession*. Are they also laws of evolution ? Are they also discoverable in embryonic development, the type of evolution ? They are, as we now proceed to show :

In reproduction the new individual appears : 1. As a *germ*-cell—a single microscopic living cell. 2. Then, by growth and multiplication of cells, it becomes an *egg*. This may be characterized as an aggregate of *similar* cells, and therefore is not yet differentiated into tissues and organs. In other words, it is not yet visibly organized ; for organization may be defined as the possession of different parts, performing different functions, and all co-operating for one given end, viz., the life and well-being of the organism. 3. Then commences the really characteristic process of development, viz., *differentiation* or diversification. The cells are at first all alike in form and function, for all are globular in form, and each performs all the functions necessary for life. From this common point now commences development in *different directions*, which may be compared to a branching and rebranching, with more and more complex results, according as the animal is higher in the scale of organization and advances toward a state of maturity. First, the cell-aggregate (egg) separates into three distinct layers of cells, called ecto-blast, endo-blast, and meso-blast. These by further differentiation form the three fundamental groups of organs and functions, viz., the *nervous system*, the *nutritive system*, and the *blood system :* the first presiding over the exchange of *force* or influence, by action and reaction with the environment, and between the different parts of the organism; the second presiding over the exchange of *matter* with the environment, by absorption and elimination; the third presiding over exchanges of matter between different parts of the organism. The first system of functions and organs may be compared to a system of telegraphy, foreign and domestic; the second to foreign commerce; the third to an internal carrying-trade. Following out any one of these groups in higher animals, say the nervous system, it quickly differentiates again into two sub-systems, viz., cerebro-spinal and ganglionic, each having its own distinctive functions, which we can not stop to explain. Then the cerebro-spinal again differentiates into voluntary and reflex systems. All of these have meanwhile separated into sensory and motor centers and fibers. Then, taking only the sensory fibers, these again are differentiated into five special senses, each having a wholly different function. Then, finally, taking any one of these, say the *sense of touch* or feeling, this again is differentiated into many kinds of fibers, each responding to a different impression, some to heat, others to cold, still others to pressure, etc. We have taken the nervous system; but the same differentiation and redifferentiation takes place in all other systems, and is carried to higher and higher points according to the position in the scale of the animal which is to be formed.

Or, to vary the mode of presentation a little, the cells of the original aggregate, commencing all alike, immediately begin to take on different forms in order to perform different functions. Some cells take on a certain form and aggregate themselves to form a peculiar tissue which we call muscle, and which does nothing else, can do nothing else, than contract under stimulus. Another group of cells take on another peculiar form and aggregate themselves to form another and very different tissue, viz., nervous tissue, which does nothing and can do nothing but carry influence back and forth between the great external world and the little world of consciousness within. Still another group of cells take still another form and aggregate to form still another tissue, viz., the *epithelial*, whose only function is to absorb nutritive and eliminate waste matters. Thus, by differentiation of form and limitation of function, or division of labor, the different parts of the organism are bound more and more closely together by mutual dependence, and the whole becomes more and more distinctly individuated, and separation of parts becomes more and more a mutilation, and finally becomes impossible without death. This process, as already said, reaches its highest point only in the later stages of development of the highest animals.

The *law of progress* is, of course, admitted to be a law of ontogeny; but observe here, also, it is true only of the whole and not necessarily of all the parts, *except from the point of view of the whole.* Thus, for example, starting all from a common form or generalized type, some cells *advance* to the dignity of brain-cells, whose function is somehow connected with the generation or at least the manifestation of thought, will, and emotion; other cells *descend* to the position of kidney-cells, whose sole function is the excretion of urine. But here, also, the highest cells are successively higher, and the whole aggregate is successively nobler and more complex. It is again a branching and rebranching in every direction, some going upward, some downward, some horizontally, anywhere, everywhere, to increase the complexity of relations internal and external, and therefore to elevate the plane of the whole.

Lastly, the law of cyclical movement is also a law of ontogeny and therefore of evolution. This law, however, is less fundamental than the other two, and is, therefore, less conspicuous in the ontogenic than in the phylogenic series. It is conspicuous only in the later stages of ontogeny and in other higher kinds of evolution, such as social evolution. For example, in the ontogenic development of the body and mind from childhood to manhood we have plainly successive culminations and declines of higher and higher functions. In bodily development we have culminating first the *nutritive* functions, then the *reproductive* and *muscular*, and lastly the *cerebral.* In mental development we have culmination first of the receptive and retentive faculties in childhood, then of imaginative and æsthetic faculties in youth and young manhood; then of the reflective and elaborative faculties—the faculties of productive work in mature manhood; and, finally, the moral and religious sentiments in old age. The first gathers and stores materials; the second vivifies and makes them plastic building materials; the third uses them in actual constructive work—in building the temple of science and philosophy; and the fourth dedicates that temple only to noblest purposes.

Observe here, also, that when each group of faculties culminates and declines it does not perish, but only becomes subordinate to the next higher dominant group, and the whole psychical organism becomes not only higher and higher in its highest parts, but also more and more complex in its structure and in the interaction of its correlated parts.

Observe, again, the necessity laid upon us by this law—the necessity of continued evolution to the end. Childhood, beautiful childhood, can not remain—it must quickly pass. If, with the decline of its characteristic faculties, the next higher group characteristic of youth do not increase and become dominant, then the glory of life is already past and deterioration begins. Have we not all seen sad examples of this? Youth, glorious youth, must also pass. If the next higher group of reflective and elaborative faculties do not arise and dominate, then progressive deterioration of character commences here—thenceforward the whole nature becomes coarse, as we so often see in young men, or else shrivels and withers, as we so often see in young women. Finally, manhood, strong and self-relying manhood, must also pass. If the moral and religious sentiments have not been slowly growing and gathering strength all along, and do not now assert their dominance over the whole man, then commences the final and saddest decline of all, and old age becomes the pitiable thing we so often see it. But, if the evolution have been normal throughout; if the highest moral and religious nature have been gathering strength through all and now dominates all, then the psychic evolution rises to the end—then the course of life is like a wave rising and cresting only at the moment of its dissolution, or, like the course of the sun, if not brightest at least most glorious in its setting. And thus—may we not hope?—the glories of the close of a well-spent life become the pledge and harbinger of an eternal to-morrow.

We have thus far illustrated the three laws of succession of organic forms by ontogeny, because this is the type of evolution; but they may be illustrated also by other forms of evolution. Next to the development of the individual, undoubtedly the *progress of society* furnishes the best illustration of these laws.

Commencing with a condition in which each individual performs all necessary social functions, but very imperfectly; in which each individual is his own shoemaker and tailor, and house-builder and farmer, and therefore all persons are socially alike; as society advances, the constituent members begin to diverge, some taking on one social function and some another, until in the highest stages of social organization this diversification or division and subdivision of labor reaches its highest point, and each member of the aggregate can do perfectly but one thing. Thus, the social organism becomes more and more strongly bound together by mutual dependence and separation becomes mutilation. I do not mean to say that this extreme is desirable, but only that an approach to this is *a* natural law of social development. *Is not this the law of differentiation?*

So also *progress* is here, as in other forms of evolution—a *progress of the whole*, but not necessarily of every part. Some members of the social aggregate advance *upward* to the dignity of statesmen, philosophers, and poets; some advance *downward* to the position of scavengers and sewer-cleaners.* But the highest members are progressively higher, and the whole aggregate is progressively grander and more complex, in structure and functions.

So, again, the *law of cyclical movement* is equally conspicuous here. Society everywhere advances, not uniformly, but by successive waves, each higher than the last; each urged by a newer and higher social force, and embodying a new and higher phase of civilization. Again: as each phase declines, its characteristic social force is not lost, but becomes incorporated into the next higher phase as a subordinate prin-

* Of course I mean downward in *social function.* Individually the scavenger may be nobler than the statesman.

ciple, and thus the social organism as a whole becomes not only higher and higher, but also more and more complex in the mutual relations of its interacting social forces.

Let us not be misunderstood, however. There is undoubtedly in social evolution something more and higher than we have described, but which does not concern us here, except to guard against misconstruction. There is in society a *voluntary progress* wholly different from the evolution we have been describing. In *true* or material evolution natural law works for the betterment of the whole utterly regardless of the elevation of the individual, and the individual contributes to the advance of the whole quite unconsciously while striving only for his own betterment. This unconscious evolution by natural law inherited from the animal kingdom is conspicuous enough in society, especially in its early stages, but we would make a great mistake if we imagined, as some do, that this is all. Besides the unconscious evolution by natural laws, *inherited from below*, there is a higher evolution, *inherited from above*, indissolubly connected with man's spiritual nature—a conscious, voluntary striving of the best members of the social aggregate for the betterment of the whole—a conscious, voluntary striving both of the individual and of society toward a recognized *ideal*. In the one kind of evolution the fittest are those most in harmony with the environment, and which therefore always survive; in the other, the fittest are those most in harmony with the ideal, and which often do not survive. The laws of this free voluntary progress are little understood. They are of supreme importance, but do not specially concern us here.

The three laws above mentioned might be illustrated equally well by all other forms of evolution. We have selected only those which are most familiar. They may, therefore, be truly called the laws of evolution. We have shown that they are the laws of succession of organic forms.

III. Thus far in our argument I suppose that most well-informed men will raise no objection. It will be admitted, I think, even by those most bitterly opposed to the theory of evolution, that there has been throughout the whole geological history of the earth an onward movement of the organic kingdom to higher and higher levels. It will be admitted, also, that there is a grand and most significant resemblance between the course of development of the organic kingdom and the course of embryonic development—between the laws of succession of organic forms and the laws of ontogenic evolution. But there is another essential element in ontogenic evolution. It is that the *forces* or causes of evolution are *natural;* that they reside in the thing developing and in the reacting environment. This we know is true of embryonic development; is it true also of the geologic succession of organic forms? It is true of ontogeny; is it true also of phylogeny? If not, then only by a metaphor can we call the process of change in the organic kingdom throughout geological history an evolution. This is the point of discussion, and not only of discussion, but, alas! of heated and even angry dispute. The field of discussion is thus narrowed to this third point only.

Before stating the two opposite views of the cause of evolution, it is necessary to remind the reader that when the evolutionist speaks of the forces that determine progressive changes in organic forms as *resident* or *inherent*, all that he means, or ought to mean, is that they are resident in the same sense as all natural forces are resident; in the same sense that the vital forces of the embryo are resident in the embryo, or that the forces of the development of the solar system according to the nebular or any other cosmogonic hypotheses are resident in that system. In other words, they mean only that they are *natural*, not supernatural. This does not, of course, touch that deeper, that deepest of all questions, viz., the essential *nature and origin of natural forces*; how far they are independent and self-existent, and how far they are only modes of divine energy. This is a question of philosophy, not of science.

As already stated, all will admit a grand resemblance between the stages of embryonic development and those of the development of the organic kingdom. This was first brought out clearly by Louis Agassiz, and is, in fact, the greatest result of his life-work. All admit, also, that the embryonic development is a natural process. Is the development of the organic kingdom also a natural process? All biologists of the present day contend that it is; all the old-school naturalists, with Agassiz at their head, and all anti-evolutionists of every school, contend that it is not. We take Agassiz as the type of this school, because he has most fully elaborated and most distinctly formulated this view. As formulated by him, it has stood in the minds of many as an alternative and substitute for evolution.

According to the evolutionists, all organic forms, whether species, genera, families, orders, classes, etc., are variable, and, if external conditions favor, these variations accumulate in one direction and gradually produce new forms, the intermediate links being usually destroyed or dying out. According to Agassiz, the higher groups, such as genera, families, orders, etc., are indeed variable by the introduction of new species, but species are the ultimate elements of classification, and, like the ultimate elements of chemistry, are unchangeable; and, therefore, the speculations of the evolutionist concerning the transmutation of species are as vain as were the speculations of the alchemists concerning the transmutation of metals—that the origin of man, for example, from any lower species is as impossible as the origin of gold from any baser metal. Both sides admit frequent change of species during geological history, but one regards the change as a change by gradual *transmutation* of one species *into* another through successive generations and by *natural* process, the other as change by *substitution* of one species *for* another by direct supernatural *creative act.* Both admit the gradual development of the organic kingdom as a whole through stages similar to those of embryonic development; but the one regards the whole process as natural, and therefore strictly comparable to embryonic development, the other as requiring frequent special interference of creative energy, and therefore comparable rather to the development of a building under the hand and according to the preconceived plan of an architect—a plan, in this case, conceived in eternity and carried out consistently through infinite time. It is seen that the essential point of difference is this: The one asserts the variability of species (if conditions favor, and time enough is given) without limit; the other asserts the permanency of specific forms, or their variability only within narrow limits. The one asserts the origin of species by "*descent with modifications*"; the other, the origin of species by "*special act of creation.*" The one asserts the law of continuity (i. e., that each stage is the natural outcome of the immediately preceding stage) in this, as in every other department of Nature; the other asserts that the law of continuity (i. e., of cause and effect) does not hold in this department; that the links of the chain of changes are discontinuous, the connection between them being intellectual, not physical.

So much for sharp contrasting characterization of the two views, necessary for clear understanding of much that is to follow.

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# SOCIAL SUSTENANCE.

By HENRY J. PHILPOTT.

## IV.—ALLOTMENT OF SPECIALTIES.

THUS far we have left untouched, as nearly as possible, one vital question relating to specialties—namely: How shall they be allotted? What task shall each of us take, and to whom shall we leave this, that, and the other task which, if we do confine ourselves to one, we must leave to others? We are not concerned about personal names, but on what principles shall the allotment be made? What kind of people shall do the weaving, what kind the newspaper work, what kind the trading? Within each office, store, or factory, how shall we judge whom to select for the management, whom for the clerkships, whom for each different manual task? Passing from the monad to the mass, which community or which country shall devote its best energies to the production of which products? How shall the nations of the earth divide its work between them?

It is only in answer to this last question that, so far as I know, any economist has given any attention to the subject of allotment. It has never been elaborated, nor allowed to be the vital, rudimental question that I conceive it to be. The result is, that even those who know the truth are constantly dropping into expressions conformable only to a false theory; just as we all speak of a "favorable balance of trade," when we know the expression conveys a wrong idea.

In regard to allotment of specialties or industries the theory which finds readiest and commonest expressions, even among those who know better, is that each task should be done by the one most capable of doing it, each industry carried on by the class, community, or country by which it can be done with the least outlay of labor and capital. By most people this is regarded as an axiom, needing no proof because admitting of no denial. They are as sure of it as their ancestors were that the sun daily revolves around the earth.

In all the hot disputes with which the free-traders and protectionists have enlivened the politics and enlightened the minds of the populace, they have rarely if ever failed to agree on the axiomatic truth of this falsehood. One wants free trade because it will secure to each industry a development in the country whose natural resources are best adapted to it. The other is able to prove, in a particular case, that his own is that country, and that therefore the Government should step in and bring about the development which somehow fails to come of its own accord. The free-trader assumes that the natural laws of trade will bring about a certain state of things which the protectionist is able to prove that they do not, but is free to confess that they would, after a few years of governmental "encouragement."

Torrence found out the true theory as applied to international trade; Ricardo enlarged upon it, and for a time secured the credit of its invention; Mill made a complicated mathematical demonstration of it; and more recent writers have been content to briefly repeat their argument, and give it the same extremely limited application. The English economists discovered that under the system of free trade their country imported things which could have been made with less capital and labor at home. In order to silence the protectionists, who had made the same discovery, they set about to find some excuse for it. In the course of the search they discovered what they conceived to be a great mathematical principle; but they were careful to explain that it applied only to international specialization, and to give the reason why it should. Capital moves freely, they said, within national bounds, but it does not freely cross them. This argument has had a surprising longevity, considering that it is not the poor countries, but the rich ones, which import the things they could produce with little effort.

In our widening field of observation, which has the further merit of lying all about us within easy reach, we shall find many after-illustrations, and a sufficient number of more satisfactory explanations of this so-called economic paradox. It is not alone, nor chiefly, in foreign trade that we must and do leave to others tasks that we can do better than they. It is, in fact, a universal and striking feature of specialization, which everybody might have observed by looking about him. Boys and women do a great many things that men could do better. The apprentice performs a task which the journeyman could do better; the journeyman, one at which the foreman excels him. Boy or man, the better he performs his task, the sooner he leaves it to some one who can not do it so well, while he rises to something higher. We all know that this is the rule. But we also know that there are exceptions. The exceptions are not only numerous, but interesting and instructive. They will be studied in their proper place. Just now we have on hand the preliminary business of citing examples of the operation of the rule.

We find it prevailing in the army, often to the salvation of a country. The best soldier is the first to be made something more than a mere soldier. The best captain is made a colonel, the best colonel a general, the best general a commander-in-chief. The best brakemen on the railroad are made conductors, the best firemen are made engineers, the best station-agents train-dispatchers or superintendents, or something still higher and further removed from their original work. Whoever is promoted leaves to others work in which he excels them. His very excellence in a task leads to his abandonment of it.

We have to note, however, that in all these cases the new specialty he adopts is rather nearly allied to the old one that he abandons. Success in the lower implies aptitudes available in the higher. There is another class of cases in which this is either not so important or not so apparent. The successful farmer first acquires enough capital to engage in some more agreeable business. The successful wage-worker in any line first gets money to buy a farm or a store or a factory, or something else that will give him an employment, perhaps totally unlike his own, and only more congenial because he can be its master and not its underling. Let it be admitted that frugality, judgment, or what not, has helped to bring about this result. They would all have failed if he had lacked aptitude for his original work, and it is not necessary that they should equal that aptitude in force. It is only necessary that the lack of them should not squander away the rewards of the aptitude. In all this class of cases capital is a prominent feature.

The most striking case of all, in which neither promotion by merit nor acquisition of capital has much to do, is that of women. That man could do most of her work better than she can is beyond doubt, since the experience has been tried. It may still be a question whether he can do all of it better. At any rate, we daily see that he does wash, iron, scrub, churn, sew, weave, knit, spin, and even cut and fit the woman's own clothes and dress her hair with such success that without any chance of favoritism he is able to make better wages than she can in the same employment. With few if any exceptions, whatever work man leaves to woman he leaves to one less capable in it, with the same training, than he. It needs only observation, not labored argument, to prove this. If we seem here to be contradicting something said in another place, the apparent contradiction will be fully explained farther on.

Thus far the true theory is capable of demonstration. Beyond this point we either see it or seem to see it exemplified every day. We hire a man to do a job of work which we have not time to do ourselves. How often rightly and how often wrongly we do not know, but at any rate quite often sincerely, we think to ourselves that with the same training we could have done it better. In some cases we know we could, as well as we know anything not fully tested; and in some cases we know it even by the successful result of a sufficiently thorough test.

Adding all these demonstrable and reasonable cases together, we are safe in saying that by far the larger portion of the world's work is done by those not most capable of doing it, either by means of their own aptitudes or of the natural resources with which they are surrounded. It remains to ask and answer the question, why this is so. Why should it be the rule rather than the exception, that we must leave to others work that we can do better than they? Certainly there can not be a more important economic question than this.

It is not compulsory that we shall be tedious, but it is compulsory that we shall be somewhat analytical. We are considering the relation of a man to a task. If we were asked to give a cold, intellectual opinion as to whether a certain man should wed a certain woman, we should have to inquire into the nature of the man and the nature of the woman. So in this case we have to inquire into the peculiarities of human beings on the one hand and of tasks on the other. If the analogy seems trivial, it is worth while to remember that a man's devotion to his chosen occupation has often caused an estrangement between him and his wife.

Directing our attention first to the tasks, we find that they are not all alike in importance. Humanity as a mass can better afford to have some kinds of work bungled and slurred over than others. So can the manager of an enterprise, and he is always looking out where best to reduce his force, if he finds he must reduce it somewhere. He may make a mistake in his choice of a victim, but he makes no mistake in judging that the retention of good men in some positions is more essential to his success than in others. It is not only more important that those positions should all the time be filled, but it is more important that they should be filled by men who will do their work rightly and make no mistakes. The mistakes of the office-boy are not so damaging as the mistakes of the head-clerk. The difference between a good and a bad fireman is of more consequence to the factory than the difference between a good and a bad journeyman. We can better afford to have a worthless or a bad Congressman than a worthless or a bad President. And so on, all the way round.

If tasks differ in importance as well as in the character of their operations, so men differ in their total industrial potencies as well as in their special aptitudes. A does not always excel Z in one kind of work only, he may excel him in several kinds or in all kinds. Nobody would hesitate to admit this if A were an able-bodied man and Z an idiotic weakling. In that case the essential difference between A and Z as industrial factors is plainly seen to be quantitative. There is more of A than there is of Z. As we are wont to say, there is more in him.

Now, the fact we have to recognize is, that all the way from A to Z there is a quantitative as well as a qualitative difference between the human beings who are helping one another to make a living. Because a man is weak in one way it does not follow that he is strong in another. Because he is strong in one way it does not follow that he is weak in all other ways. So one country may excel others in a great variety of resources as well as in one. No doubt we could find two countries of which one excelled the other in every capacity for the sustenance of man, and yet under the most absolute freedom trade would go on, and ought to go on, between the two countries.

Let us define our use of the term special aptitude. Let us use it with reference to the other aptitudes of the same person or country, not with reference to those of another person or country. When we say that a person has a special aptitude for a certain work, let us mean that, while he may not be good at that work, he is better at that than at anything else.

When a person is apter at one thing than another, it may be that he is really and positively apt at that thing, or the trouble may be only that he is inapt at the other. A special aptitude is entirely consistent with, and may even proceed from, a general inaptitude.

On what principles, then, shall the allotment of specialties be made?

1. The most important specialties will naturally and rightly command the services of the persons most competent in them.

2. The demands of those which, from the nature of the soil or its occupants, are most profitable, will and should be met.

3. Each person should do the work at which he can earn most, whether or not he is as capable as others in the same work, and whether or not he must leave to others work in which he is more capable than they.

4. The incapable must be allowed to bungle away at some kind of work rather than waste their time.

5. The same privilege must be accorded to those who, like most women, are prevented by circumstances from exercising even the industrial powers they have or might under other circumstances develop.

And speaking of woman, what we have said in another place of her inherited special aptitude must be taken in connection with what we have just said of the relativity of the term aptitude. No matter how much stronger she may be morally, she is industrially weaker than man, and even in her own special aptitude, which nevertheless is a special aptitude, she is weaker. An exception may be made in regard to her care of children, so far as it is an industrial task to be included in the study of political economy; but at any rate the cooking and the children keep her at home, and, as a rule, she must either chore about the house or do nothing most of her time, leaving unsatisfied the instinct of mutual help in social sustenance, and leaving humanity that much short of its amplest possible life.

What we are striving for is that both the competent and the incompetent shall be employed and to the best advantage. The competent must therefore do the work at which he most excels the incompetent, and the incompetent must toil and sweat over a task which the competent could do better and more easily. It is the competent, the rich, the fortunate, the versatile, who leaves to others work that he could do better than they. Mediocrity sticks to one task through life. This is the rule. We promised to point out the exceptions. They are the men of one aptitude or one acquired skill highly developed, but barred by bad habits, lack of enterprise, lack of judgment, or some other similar lack, from rising to a higher and more profitable task. If that one aptitude is itself a high one, we can hardly call the man mediocre. If it is a somewhat lower one, we may say that he is a prodigy in his way. Going on down, we reach a point where we have no hesitation in saying that no attainable development of the one faculty could lift the man above the average of his fellows.

But, as a very general rule, the man who from choice leaves to another work in which the first excels the second is the one of the two who is to be most congratulated. The other is still to be congratulated, for it gives him a job. Both parties are benefited. We never think of commiserating a man, no matter how capable he may be at his work, who has a chance to earn more at no matter how different a task, leaving his former one to no matter how sad a bungler. Why should we deplore the fact that nations are able to do the same thing? The statesmen at Washington who consider it a disgrace that America should import things for whose domestic production it has plenty of skill and ample natural resources, would let the scrubbing and care of the building in which they say these things be ever so badly botched before they would take hold and do the work themselves. No doubt the least able-bodied of them could, with an hour's practice every day, soon do it better and more easily than it is done, at least that part of it that is done by women.

He not only never thinks of trying it; he never feels it the slightest disgrace to let a woman do for him work that he would be ashamed to admit his inability, with a tenth of the training, to do better than she. In many cases, perhaps a majority, he could do it without any training if he were thoroughly in earnest. Suppose that it were proved beyond his own doubt to be so in the case of any statesman. Would he drop his work and take to the floor-cloth? Would he even spend his idle hours in that way? If a proposition to do so were made him, he would reject it on two grounds. He would not hesitate to say that it injured both himself and the woman. It would reduce his own opportunities for the enjoyment of life, and it would reduce the woman's opportunities for the sustenance of her life.

He is right. In his own case and in the domestic allotment of specialties he gets at the right principle by instinct as well as by reasoning. It is when he comes to apply the same principle to international allotment of specialties that by some strange infatuation he goes wrong. He plainly sees that when the man A leaves to the man or woman B work that he could do with less effort and higher success, both A and B are benefited. What he does not see is that in like manner when the country A leaves to the country B the prosecution of industries in which A might excel, both countries are benefited.

He is not without some excuse for his mistake. The country A always has in it some men and some capital seeking employment. Why not employ these before we generously leave to others work for which we have greater advantages than they? Why not domesticate some foreign industry which will give them work? For the same reason that a man who loses a good job waits awhile and hunts another good one, rather than tie himself to a bad one. There are always displacement and transitory idleness for a part of both the labor and capital of a country which is making progress. It may be painful for a time to the temporarily idle and displaced, but it is part of a necessary process of readjustment and replacement. Hence, it is better for all—immediately better for some, and finally better for even the temporarily displaced. This, of course, when the displacement comes as a result of progress, as in the invention of a new machine, the opening of new routes of commerce, or the better organization of industry. If it comes from the exhaustion of mines, a shortage of money, a collapse after over-speculation, or some other cause which is retrogressive rather than progressive, then, indeed, will the idle capital and labor, if given sufficient time, take up industries formerly left to other countries, and will need no government stimulation to do so. Increase of population has this natural effect. A declining or crowded country is forced into less profitable industries, taking them away from the countries where, while not so profitable, they have been the most profitable within the reach of the unfortunate inhabitants. It thus employs a part of the labor and capital thrown out of work by its decline or crowding.

The capital thrown out of work by industrial progress will, if not destroyed, soon find better work, and so will the labor, if accompanied by sufficient energy and versatility to seek it. But, so long as there is progress, there will be a certain portion of the labor and capital of a country which will be in a state of flux. Mobility of capital and labor is, in fact, a condition of industrial evolution, just as the unstable equilibrium of matter is a condition of all evolution. It is a condition of the growth and development of the human body that part of the cells of which it is composed to-day shall be thrown out of work to-morrow.

The equanimity of our study of political economy is always disturbed by its manifest inequalities and misfortunes. We plainly see and deeply lament the inequality in the apportionment of land and capital, and vainly try to remedy it. But is there not quite as great inequality in the apportionment of industrial powers? And where is the remedy? Which of us, by taking thought, can add a cubit to his stature? Can the Government by its force, or the economist by his advice, do it for us? And if they lack the power to make us industrially equal, what else can they do for us that will make up for this lack? Is there not here the greatest of all the advantages of one human being over another?

Would not, in fact, the equality of land and capital merely emphasize the other and confessedly irremediable inequality? The drudges who make a poor living work as hard, and their work wears as painfully on their nerves, as can be said of the competent who without land or capital are able to make a good living. Are they then to be given a good living for little or unimportant work? Not until some way is found to highly reward the man who does little because he is incapable, without encouraging the capable man to do little because he is lazy.

So much for inequality. But inequality is not the only misfortune. Aside from the fact that industry is not organized to its best advantage, is it not also apparent and regretable that under any organization we are a race of sad bunglers; and that so much of the work of sustaining social life must be done by those who are bunglers even in comparison with their fellow-beings? And what is the remedy for this?

We are growing out of it, and may still grow out of it, as also out of the inequality. And this fact that most of our progress must be growth need not discourage us from doing what we see can be done to promote the progress; our doing so will constitute a part of the process of growth. But we can do it better if we recognize that another part of the process is beyond our control, if not entirely beyond our aid; for then we shall be better able to judge when we are working in the right direction, and to make our work help rather than hinder that of the overruling Power which is pushing us on to our destiny.

# THE OLDEST NOBLE OF THEM ALL.

By CARL VOGT.

WE sailed out from the little port of Alleghero, on the northwest coast of Sardinia, on a clear morning, with a bright sun, light breeze, and a moderate flow of tide, to the nearest coral banks. Our fishing-apparatus consisted of a large wooden cross-drag weighted with lead, to which ropes and nets were attached, which was to be painfully hauled over the bottom of the sea at a depth of from one hundred to two hundred metres, to gather what it could catch of the life abiding in those regions. The success of the operation depends largely on the skill and discrimination of the padrone. Two sailors and a youth manage the very primitive capstan by which the rope, that the padrone holds in his hand, is unrolled. He knows, by feeling the movements of the rope, its tension, sliding, and jerking, whether the drag is passing over sand, mud, hard ground, or solid, jagged rock. At times the youth stands alone at the capstan, and the sailors take the rudder in hand and turn the vessel as the padrone directs. Sometimes they have to work with all their might, as when the apparatus gets fastened or is drawn under overhanging rocks. There are a thousand accidents to be guarded against, and they frequently end in the loss of the drag.

Thus the sea-bottom is swept for a few hours as with a broom. The cords of the drag sling themselves around everything that projects and is movable ; large pieces of rock are ensnared and torn loose with all that is upon them. Whatever creeps upon the ground is made fast.

The padrone orders a halt, and the sailors apply themselves to the capstan to draw in the rope. It is a task calling for the exertion of their full strength to dislodge the apparatus and pull it up with the heavy load which it has collected. Sometimes the leverage of the sea-waves is invoked. The capstan is locked, the rope is stretched to its utmost, and the bark is set by a few motions of the rudder upon the crest of a rising wave. The reaction, when the machine is dislodged, is often so strong as to threaten to overturn the bark. A cloud of slime announces the approach of the apparatus to the surface. The drag is pulled out and laid upon the ship's edge, and the nets which are swimming around are drawn in and thrown into the inner space. Capstan and helm are deserted, and the sail is drawn in. The men squat in a ring around the net, and pick out with their fingers the objects that are entangled in it, and sometimes the knife has to be used to solve some unusual complication. I had filled my pail with clear sea-water before the apparatus was drawn up. I had given orders, which were very difficult to get executed, to have nothing cast overboard, so great was the temptation to the men to judge this or that piece of coral worthless and throw it away. After taking a lunch, I took out my instruments which I had provided for the occasion, and made a careful examination of the stones, to see what life might be upon them, scrutinizing every cavity and crevice closely with the lens. At last I found the particular object of which I was in search. It was a little shell about the size and thickness of a lentil, which had grown fast to the stone by a piece of its edge. It was of a dingy, brownish color, with a dim red spot in the middle, and was so covered with slime and mud that it could hardly be distinguished from a stone-splinter. I loosened it with a knife and exhibited it to the boatmen on the palm of my hand. "Look at it sharply," I said, "so that you will be able to recognize it anywhere, and then help me to look for more." In the course of half an hour every stone had been examined, and three or four shells had been obtained, among them a larger one, yellowish-green and three-cornered, which was attached by the tip. "Your Excellency," said one of the sailors, "are there no such shells in the country you came from?" "In Switzerland?" I replied. "No. These shells grow only in the sea, and there is no sea in Switzerland." "That is a good way from here, and the journey must have cost a great deal of money. We are very simple people, your Excellency, and must believe you; but we can not understand why you should have come so far and spent so much money just to get two or three poor little shells that are not worth any money." "But I tell you it is worth a great deal to me to see these shells living." "But you can't sell the shells and get your money back again?" "Certainly not, but I have another kind of interest in them." "We believe, indeed, that something else must be hidden behind this, and that is what we should like to know; but it does not concern us any further. We give you the shells because you have paid us for them, and wash our hands in innocence. You are responsible for what else is done with them; but a prudent man does not act as you do. Don't consider it wrong in us, your Excellency. We should like to earn enough in this business to devote a candle to the Madonna of Valverde, with which we may atone for our sins, and the Madonna will pardon us if we have helped on a little foolery or witchcraft to earn a little money by it."

It had come to this, then, that I was a fool or a wizard. I should clearly have to give some explanation of my business to these men; but it would be impossible to make their simple heads take the conception of science or of scientific interest. So I was obliged to make up a little fiction or allegory with which to put them off, and I told them that I wanted the shells to settle a wager. I had been present at a discussion, I said, a long time ago, in the company of Prince Humbert (now king), as to which were the oldest noble families on the earth. Some were of the opinion that they were to be found in this nation and some in that, when I interfered and said that I knew of a much older nobility than any that they had brought forward—of one that was present at the creation of the world. The crown-prince, intimating that my mere assertion could not carry the day, invited me to produce a living shoot of that old stock. I told him that I would do so if I were given time, and he granted me as long an indulgence as I desired. Some years had passed since my promise was made; but now I desired to fulfill it, and had come to this place to get the living shoots of the oldest family on the earth. What I had asserted was the simple truth. The ancestors of these shells have lived in the sea ever since there was a sea, "and now I shall take these living muscles to the king and tell him that I have won the bet."

Let us look now at the little company which is collected here on a stone, and whose individual members are found in the Mediterranean Sea. The largest of the specimens on the right side of the drawing,

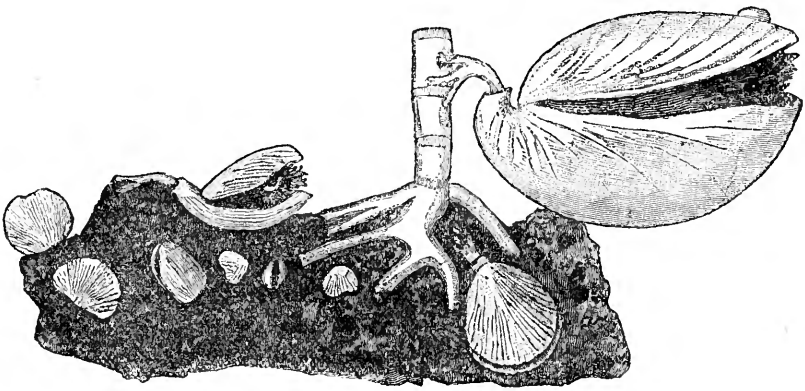

Fig. 1.—Members of the Oldest Family.

which has grown by a short stalk to a small coral-stem, represents a smooth shell, of glassy clearness, and hard as glass. Linnæus was acquainted with it, and called it *Terebratula vitrea*, or the glassy terebratula. Another much smaller kind, whose white, three-cornered shells are neatly furrowed in the direction of their length, is supposed to have a kind of resemblance which I have never been able to find, with a snake's head, and is named in the classification *Terebratulina caput serpentis*. Two specimens can be seen in the drawing, one in the right-hand lower corner of the stone, on the surface; the other on top near the middle, in profile. On the Sardinian coast this species wears a yellowish-green coat, which consists of a slime sticking fast to the shell with sand-grains. I thought at first that I had discovered a new species, and would be able to perpetuate my name in the zoölogical registers till the end of science, by giving it to this creature, when my zeal unluckily prompted me to take hold of the soft coat with a pincers. The tool drew off the envelope and under it shone the ivory-white shell. Besides these two species belonging to the family of the *Terebratulæ*, there are two smaller shells on the stone. The smallest species, of which three specimens lie on the middle of the stone, has the form of a heart, which is attached by its point. It shows a few dull-red spots on the middle of the shell, and is named *Argiope.* The other one, a little larger species, appears at the left in three specimens, with a straight hinge-border, and is broad and firm, and is called *Megerlea.*

We placed this piece of stone with its four species of shells, to which others that abound in the Mediterranean might be added, into a pail filled with sea-water, in which several other animals were stirring. We intended to watch the life-expressions of these fixed animals. Our patience was exposed to a hard trial. Hours passed away, without our being able to perceive the slightest movement. We had become tired and were yawning, when we thought we perceived the little *Argiope* mocking us. It was, in fact, gaping. The *Megerlea*, the snake-head terebratula, and the glass terebratula, followed its example and yawned too, but as discreetly as if they were in well-bred society. The valves parted from one another only a little ; a few fine, glassy, glistening hairs, which could only be seen with the glass, appeared outside. That was all. Terebratulas have been kept for weeks and months living in glass vessels filled with sea-water, without any other movement being perceived than this gaping, which sometimes continued for hours. When they had gaped enough, they shut their shells, slowly and measuredly, as if they would sleep ; and, when they had slept enough, they gaped again. Old noble by entail, which has grown fast to its estate, and sleeps or gaps its life away ! But what do they feed upon ? A closer investigation was required to find that out.

The two valves of the shell are not alike. The difference is greatest in the terebratula. One valve is wide, bellied, and runs into an upward-turned beak perforated by a round hole through which passes a short, round stem that is resolved outside of the shell into a bundle of thongs by which the animal fastens itself. The smaller valve rests as a cover upon this one.

We try to open the valves as they are opened in the gaping, but it is impossible to do it without force ; so we have to break the shell open. Fig. 2 shows the opened snake-head terebratula magnified six times. The bellied valve is filled with two peculiar, half-moon-shaped processes, consisting of two bent, cartilaginous pipes, on the outer side of which stand a number of fringes which wind in a worm-fashion and circulate in constant movement. The space between these great arms, as they are called, includes two smaller arms, provided with similar fringes, which roll up helicoidally toward the bottom. Nearly all the space of the bellied shell is occupied by these forms ; except that above, toward the point of the valve, may be seen some muscles, which open and shut the shell, and conceal from view the very small body proper. In this may be found a short bowel with a large liver, the nervous system, and, perhaps, also the heart. The bowel has a real mouth only at the junction of the two arms, but is entirely closed at the other end. The inner surface of the valve is covered with a fine, transparent skin, which is called the mantle, in the somewhat thickened border of which are planted the stiff, transparent bristles, which are moved back and forth by the contraction of the membrane in which they are fixed. The organs of generation also lie in the mantle, and are shown in the drawing as two lumps in the raised back valve. Thus, small is the body in proportion to the vigorously developed arms, from which the name of the whole class, *brachiopods*, is derived. But are they really arms? They are hardly movable. If we stick a needle into one of them, it does not stir ; and there are species in which they are completely calcified. Only the fringes move and respond immediately to excitations.

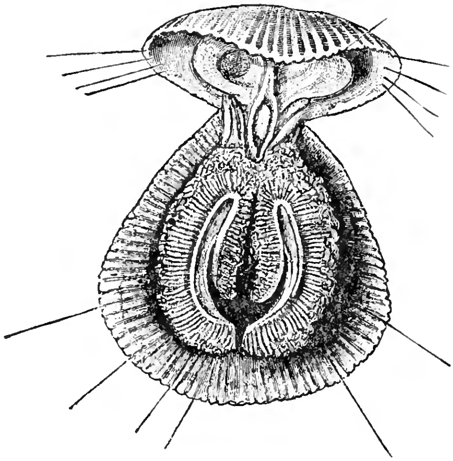

FIG. 2.—ANATOMY OF A BRACHIOPOD.

We cut off a piece of the arm and place it under the microscope. Each fringelet is a tube made of a firm, elastic membrane, in the hollow of which are laid one or two bundles of fibers of a muscular or nervous character. On the outside the tubes are clothed with delicate cells connected into a texture bearing fine, actively vibrating ciliæ. These ciliæ generate a bubbling stream in which dance the minute bodies that are floating in the sea-water. The whole stream, which the ciliæ of the thousands and thousands of tubes produce, flows from the periphery toward the mouth. The little tubes all open into the chief pipe of the arm, and are, like that vessel, filled with fluid.

With this observation a considerable number of functions are explained at the same time. The fluid in the little tubes and the chief pipe doubtless plays a part in the movements, in that it is at times pressed into the smaller vessels and expands them, and at other times is held back by the foldings and contractions brought about by the muscles in the chief pipe of the arm. But the constant stream which the ciliæ keep up is all the time bringing new particles of water, heavily charged with oxygen, in contact with the inner surface of the mantle. An exchange of gases through their thin walls is certain to arise ; the stream also produces a respiration, which is simply an exchange of the carbonic acid generated within the tissues of the body for the oxygen that is held in the water. The stream also whirls minute bodies, microscopic animals and plants, to the mouth, which swallows them. Our terebratula has no other means of getting food. As the oyster and the rotifer are fed by the streams and whirlpools produced by the ciliæ, so also is the terebratula. When the shell is closed, only the exchange of gases takes place; but when it is opened, or when the animal is gaping, it is eating, for these larger bodies are drawn in through the whirling. That this really takes place is shown by the contents of the stomach, in which we may observe undigested remains, the silicious shells of plants, diatoms, or *Radiolariæ*, and the needles of fungoids. The organic substance is digested and dissolved in the stomach, while the undigested remains are expelled through the mouth. Sea-water, especially near the ground, to which the terebratulæ are attached, swarms with shell-protected and naked matter of this kind. The terebratula is, moreover, in the happy situation of having nothing to do but spit out the shells, for the meat itself flies into its mouth.

Every fixed animal produces moving young. Were this not the case, the animals could not be distributed into spaces beyond their immediate abode. Very curious young are produced from the eggs of our arm-foots, which do not at first resemble their parents at all; larvæ that swim around in freedom, having eyes, and armed with bristles. They so much resemble the larvæ of some of the ringed worms, that one would be apt to suppose at first sight that they were of that kind. But after a time of wandering they settle themselves down, and there then takes place, with the formation of the shell, a retrograde metamorphosis, by which the animal is gradually brought back to its definite form. It is therefore easy to conceive that our arm-foot leads a very safe life, and that, protected as much as possible against enemies and other dangers, it can spin out its existence as long as the sea does not dry up. Of course, in their younger days, the wandering larvæ may be swallowed up in numbers by other animals, but when the young brachiopod is once fixed, the shell, the mantle-edge with its bristles, and the ciliary apparatus protect it so well, that not even parasites can attack it. Although fungoids, other animals, and occasionally fellow-beings of its own race may establish themselves on the outside of its shell, and load it to a certain extent, but otherwise do it no harm, no parasite has ever been seen within. The little wart that appears on the glass terebratula in the picture is one of their young. There have always been fishes which, after a fashion, eat corals and crush them with their hard teeth, to digest the polyps which the corals contain, and expel the lime-substance; but I hardly think they would take in the arm-foots, whose bodily substance is so stringy and yields so little nourishment. In the deep sea, also, the animals are thoroughly protected against the sudden changes of temperature which animals living in shallow waters and near the shores have to encounter.

I now come to my oldest noble. It is an established fact that in the most ancient strata in which fossil remains have been found, in the system called Cambrian, in the primordial fauna, shells occur which differ but little from the living arm-foots of to-day. These older or palæozoic strata fairly swarm with arm-foots; many rocks are entirely made up of them, and the richness of their forms is inexhaustible. From these earliest ages on, the animal creation gradually assumed more definite shape as the number of individual arm-foots diminished. Doubtless the more perfectly-formed organism superseded the others in the struggle for existence. The noble who relies for the support of his position only on the age of his race-stock, must die out at last if he can not adapt himself by a further development to the demands of the new time. This the arm-foots could not do: they show no progress toward a higher stage of organization. The comparatively rare brachiopods of our seas are therefore only the scanty relics of departed glory, isolated survivals of a type that was formerly wide-spread and numerous in all the seas. But it is wonderful that a race-shape should have maintained itself quite unchanged through all the geological epochs to our own time!

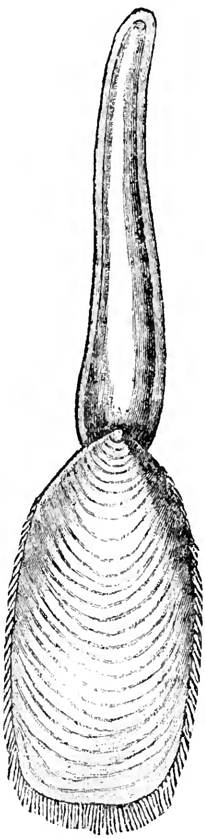

Fig. 3.—The Lingula.

At shallow places in southern seas, there creep a kind of brachiopods in the sand whose shaping is rather like that of a worm than of a brachiopod. It is called the *Lingula*, or *tongue-mussel* (Fig. 3.). This creature has an even, somewhat horny shell, and a relatively long and thick stem which is clothed within by a tough layer of muscle. Along with the other species of its kind, it is distinguished from the rest of the family by the shell having no closure, while the bowel, after many turns within the body, opens without. As the valves of the shell only cover the animal, but are not closed tight, they can be easily opened and also moved sidewise upon one another. The animal is never fixed. This is the oldest animal form of the present existing creation. Lingula-shells appear in the Cambrian strata, and have been found in all the geological systems. So far as it is possible to judge from the shells, the genus has propagated itself unchanged through all the earth-history of organisms, has survived all revolutions, and has only varied into a few species differing but little from one another.

In the Silurian strata immediately following these, in which so far nearly two thousand species of arm-foots have been found, are two other still living genera: the one, *Discinisca*, without closure, but furnished with a muscular stalk; the other, *Rhynconella*, having a shell-closure and a fibrous, but not further contractible, stem. Most of the genera living to-day can boast of a high age. *Terebratula* traces its race-stock back to the Devonian system, as does also *Crania*, while *Argiope*, *Megerlea*, and *Terebratulina* derive their ancestors from the Jurassic.

Our oldest vertebrate is a rare fish called *Ceratodus*, which lives in some of the Australian rivers. It has a few relatives living in the rivers and marshes of Central Africa and South America, and is adapted to breathe in the air through lungs and in the water through gills. Teeth of species of *Ceratodus*, clearly recognizable by their peculiar formation, appear in the muschelkalk of Würtemberg and Central Europe. Old as the race of the *Ceratodus* may be, it can not compare with that of the primeval genus *Lingula*.

I told my coral-fishers a falsehood in my story of the bet, but, as in every fiction there is a grain of truth, there is in this one the fact of the existence, in the present animal world, of a family of extremely anciently descended nobles, whose ancestors were members of the first animal creation visible to our eyes.—*Translated for the Popular Science Monthly from Ueber Land und Meer.*

## STRANGE MEDICINES.

By Miss C. F. GORDON CUMMING.

QUICKLY—by far too quickly for the sake of the student and the archæologist—is the wave of foreign influence over-sweeping Japan, ruthlessly effacing all the most marked characteristics of native manners and customs, and substituting the commonplaces of every-day European life.

Already this tendency to exalt and to adopt foreign novelties meets the traveler at every turn, and only he who turns aside from the tracks most subject to foreign influence can hope now and then to find some stanch conservative who, in that nation of ultra-radicals (albeit most loyal imperialists), has the courage to adhere to his own old-fashioned ways.

I had the good fortune to meet with such a one in the very interesting old city of Osaka—a compounder of just such strange medicines as were administered to our British ancestors in the middle ages. So rapidly has the scientific study of medicine been taken up by the Japanese medical practitioners, that the survival of such a chemist of the pure and unadulterated old school is quite remarkable; and I was greatly struck by the evident annoyance of a Japanese gentleman to whom I expressed my interest in this mediæval chemist, and who evidently felt it humiliating that a foreigner should have seen such a relic of the days of ignorance.

The quaint old man whose loyal adherence to the customs of his ancestors afforded me such an interesting illustration both of old Japan and old Britain was a seller of *curoyakie*—i. e., carbonized animals; in other words, animals reduced to charcoal, and potted in small covered jars of earthenware, to be sold as medicine for the sick and suffering. Formerly all these animals were kept alive in the back premises, and customers selected the creature for themselves, and stood by to see it killed and burned on the spot, so that there could be no deception, and no doubt as to the freshness of their charred medicine. Doubtless some insensible foreign influence may account for the disappearance of the menagerie of waiting victims and their cremation-ground; now the zoölogical back-yard has vanished, and only the strange chemist's shop remains, like a well-stored museum, wherein are ranged portions of the dried carcasses of dogs and deer, foxes and badgers, rats and mice, toads and frogs, tigers and elephants.

The rarer the animal, and the farther it has traveled, the more precious apparently are its virtues. From the roof hung festoons of gigantic snake-skins, which certainly were foreign importations from some land where pythons flourish, Japan being happily exempt from the presence of such beautiful monsters. I saw one very fine piece of a skin, which, though badly dried and much shrunken, measured twenty-six inches across, but it was only a fragment ten feet in length, and was being gradually consumed, inch by inch, to lend mystic virtue to compounds of many strange ingredients. I was told that the perfect skin must have measured very nearly fifty feet in length. I saw another fragment twenty-two feet long and twelve inches wide; this also had evidently shrunk considerably in drying, and must, when in life, have been a very fine specimen.

There were also some very fine deer's horns (hartshorn in its pure and simple form), a highly valued rhinoceros-horn, and ivory of various animals. My companion was much tempted by a beautiful piece of ivory about ten feet in length. I think it was the horn of a narwhal, but the druggist would only sell it for its price as medicine, namely, ten cents for fifty-eight grains, whence we inferred that the druggists of Old Japan, like some nearer home, fully understand the art of making a handsome profit on their sales. Some tigers' claws and teeth were also esteemed very precious, and some strips of tigers' skin and fragments of other skins and furs proved that these also held a place in the pharmacopœia of Old Japan, as they continue to do in China (the source whence Japan derived many branches of learning, besides the use of letters).

Unfortunately for the little lizards which dart about so joyously in the sunlight, they too are classed among the popular remedies, being considered an efficacious vermifuge; so strings of their ghastly little corpses are hung in festoons in many village shops, where I have often looked wonderingly at them, marveling in what broth of abominable things they might reappear. So lizards and dried scorpions (imported as medicine) also found a place in this strange druggist's shop—an "interior" so wholly unlike anything I have ever seen elsewhere, that the recollection of it remains vividly stamped on my memory—the multitude of earthenware jars containing the calcined animals all neatly ranged on shelves, the general litter of oddities of various sorts strongly resembling an old curiosity-shop, and, in the midst of all, the eccentric old man, who might have passed for a Japanese wizard rather than a grave physician. It was a strangely vivid illustration of what must have been the general appearance of the laboratory of the learned leeches of Britain in the days of our forefathers.

Before glancing at these, however, it may be interesting to note a few details of kindred medicine-lore in China, on which subject a member of the French Catholic mission, writing from Mongolia, says: "May Heaven preserve us from falling ill here! It is impossible to conceive who can have devised remedies so horrible as those in use in the Chinese pharmacopœia; such as drugs compounded of toads' paws, wolves' eyes, vultures' claws, human skin and fat, and other medicaments still more horrible, of which I spare you the recital. Never did witch's den contain a collection of similar horrors."

Mr. Mitford has told us how, also at Peking, he saw a Chinese physician prescribe a decoction of three scorpions for a child struck down with fever; and Mr. Gill, in his "River of Golden Sand," mentions having met a number of coolies laden with red deer's horns, some of them very fine twelve-tine antlers. They are only hunted when in velvet, and from the horns in this state a medicine is made which is one of the most highly prized in the Chinese pharmacopœia.

With regard to the singular virtues supposed to attach to the medicinal use of tiger, General Robert Warden tells me that on one occasion when, in India, he was exhibiting some trophies of the chase, some Chinamen who were present became much excited at the sight of an unusually fine tiger-skin. They eagerly inquired whether it would be possible to find the place where the carcass had been buried, because, from the bones of tigers dug up three months after burial, a decoction may be prepared which gives immense muscular power to the fortunate man who swallows it!

I am indebted to the same informant for an interesting note on the medicine folk-lore of India, namely, that while camping in the jungle, one of his men came to entreat him to shoot a night-jar for his benefit, because from the bright, prominent eyes of this bird of night an ointment is prepared which gives great clearness of vision, and is therefore highly prized.

Miss Bird, too, has recorded some very remarkable details on the materia medica of China and Japan. When in a remote district of Japan, she became so unwell as to deem it necessary to consult a native doctor, of whom she says:

> He has great faith in *ginseng* and in rhinoceros-horn, and in the powdered liver of some animal, which, from the description, I understood to be a tiger—all specifics of the Chinese school of medicines. Dr. Nosoki showed me a small box of "unicorn's" horn, which he said was worth more than its weight in gold.

She adds:

> Afterward, in China, I heard much more of the miraculous virtues of these drugs, and in Salangor, in the Malay Peninsula, I saw a most amusing scene after the death of a tiger. A number of Chinese flew upon the body, cut out the liver, eyes, and spleen, and carefully drained every drop of the blood, fighting for the possession of things so precious, while those who were not so fortunate as to secure any of these cut out the cartilage from the joints. The center of a tiger's eyeball is supposed to possess nearly miraculous virtues; the blood, dried at a temperature of 110°, is the strongest of all tonics, and gives strength and courage, and the powdered liver and spleen are good for many diseases, . . . and were sold at high prices to Chinese doctors. A little later, in Perak, I saw rhinoceros-horns sold at a high price for the Chinese drug-market, and was told that a single horn with a particular mark on it was worth fifty dollars for sale to the Chinese doctors.

One of the said rhinoceros-horns was, as we have seen, among the most valued treasures of the old druggist of Osaka. This horn and that of the unicorn (which seems generally to mean the narwhal*) have ever been held in high repute throughout the East as an antidote to poison, and cups carved from these horns were used as a safeguard because they possessed the property of neutralizing poison, or at least of revealing its presence.

And indeed the same virtue was attributed to it by the learned leeches of Europe. At the close of the sixteenth century the doctors of medicine in Augsburg met in solemn conclave to examiae n specimen of unicorn's horn, which they found to be true *monoceros*, and not a forgery; the proof thereof being that they administered some of it to a dog which had been poisoned with arsenic, and which recovered after swallowing the antidote. They further administered *nux-vomica* to two dogs, and to one they gave twelve grains of unicorn-horn, which effectually counteracted the poison; but the other poor dog got none, so he died. Similar statements concerning this antidote, and also concerning the value of elks' and deer's horns powdered as a cure for epilepsy, appear in various old English medical works of the highest authority.

Very remarkable, also, is the efficacy supposed to attach to antediluvian ivory, more especially the tusks of the mammoths, which have been so well preserved in Siberian ice that their very flesh is

* *Monodon monoceros.*

still sometimes found untainted. There they have lain hermetically sealed for many a long century, and now, when the rivers from time to time wash away fragments of the great ice-cliffs, they reveal the strange treasures of that wondrous storehouse — sometimes a huge unwieldy hippopotamus, or a rhinoceros, or it may be a great woolly elephant with a mane like a lion and curly tusks; and the hungry Siberian bears and wolves fight and snarl over these dainty morsels, which are still as fresh as though they had fallen but an hour ago.

Here, in these marvelous ice-fields, lie inexhaustible stores of finest ivory, and this it is which the learned professors of the Celestial medical hall value so highly. So these precious tusks are dragged forth after thousands of years, to be ground down and boiled to a jelly for the cure of vulgar Chinese diseases of the nineteenth century! Alas, poor mammoth!

Nor are these the only antediluvian relics which are thus turned to account. Professor H. N. Moseley tells us of the "dragon's teeth and bones" which he bought from the druggists of Canton, where they are sold by weight as a regular medicine, and are highly prized in the materia medica both of China and Japan as specifics in certain diseases. They proved on examination to be the fossil teeth and bones of various extinct mammalia of the Tertiary period, including those of the rhinoceros, elephant, horse, mastodon, stag, hippotherium, and the teeth of another carnivorous animal unknown.

He obtained a translation of the passage in the medical works of Li She Chan which specially refers to the use of this medicine. It states that "dragons' bones come from the southern parts of Shansi, and are found in the mountains." Dr. To Wang King says that if they are genuine they will adhere to the tongue. "This medicine is sweet and is not poison. Dr. Koon certainly says that it is a little poisonous. Care must be taken not to let it come in contact with fish or iron. It cures heart-ache, stomach-ache, drives away ghosts, cures colds and dysentery, irregularities of the digestive organs, paralysis, etc., and increases the general health."

Another medical authority, "The Chinese Repository," published in Canton A. D. 1832, states that the bones of dragons are found on banks of rivers and in caves of the earth, places where the dragon died. Those of the back and brain are highly prized, being variegated with different streaks on a white ground. The best are known by slipping the tongue lightly over them. The teeth are of little firmness. The horns are hard and strong; but if these are taken from damp places, or by women, they are worthless.

From his examination of these so-called relics of the dragon (which prove to belong to so many different animals, which in successive ages have crept to the same cave to die), Mr. Moseley points out how some imaginative person probably first devised a fanciful picture of the mythical animal, combining the body of the vast lizard with the wings of a bat, the head of a stag, and carnivorous teeth, which has become the stereotyped idea of the dragon in all lands.

Even in Europe fossil bones thus found together in caves were long known as dragons' bones, and accounted useful in medicine. Indeed, so great was the demand for these and similar relics, that our museums and scientific men have good cause to rejoice that their ancestors failed to discover what stores of old bones lay hidden in our own seaboard caves—as, for instance, in that wonderful Kirkdale cavern, where the mortal remains of several hundred hyenas were found, guarding the teeth of a baby mammoth, a patriarchal tiger, a rhinoceros, and a hippopotamus; or the caves along the Norfolk coast, where Hugh Miller tells us that within thirteen years the oyster-dredgers dragged up the tusks and grinders of five hundred mammoths; or those wonderful zoölogical cemeteries where the fossil bones of cave-lions, cave-hyenas, elephants, mammoths, hippopotami, woolly rhinoceros, red deer and fallow deer, oxen, sheep, and horses, have lain so securely, stored for untold ages beneath Charing Cross and Trafalgar Square.

After all, this reduction of prehistoric bones and ivory to vulgar powders for medicinal use is not more strange than the fossil food which forms so large a part of the daily bread of multitudes of our fellow-creatures in Lapland, Finland, and Sweden, in Carolina and Florida, on the banks of the Orinoco and of the Amazon, where vast tracts of earth are found composed wholly of myriads of microscopic shells, and this strange mountain-meal, being duly mixed with meal of the nineteenth century, is freely eaten by the people. In Lapland alone, hundreds of wagon-loads are annually dug from one great field, and there are men who eat as much as a pound and a half per diem of this curious condiment. We hear of fields, as yet untouched, having been discovered in Bohemia, Hungary, and other parts of Europe; so perhaps we may ere long add these primeval atoms to the delicacies of our own tables.

Of the firm belief of the Chinese in the efficacy of medicines compounded of the eyes and vitals of the human body we have had too terrible proof; for it is well known that one cause which led to the appalling Tientsin massacre in 1870 was the wide-spread rumor that the foreign doctors (whose skill all were forced to admit) obtained their medicines by kidnapping and murdering Chinese children and tearing out their hearts and eyes! As this nice prescription is actually described in their own books as a potent medicine, the story obtained ready credence, and we all remember the result. Moreover, the same accusation has repeatedly been spread on other occasions of popular excitement against foreign teachers.

I am not certain whether the Lamas of Peking have there introduced the fashion of administering medicine from a drinking-cup fashioned from the upper part of a wise man's skull; but such medicine-cups are greatly esteemed in Thibet, where they are mounted in gold, silver, or copper.

Such details as all these are apt to sound to us strangely unreal as we read them somewhat in the light of travelers' tales, with reference to far-away lands; but it certainly is startling when, for the first time, we realize how exactly descriptive they are of the medicine-lore of our own ancestors—in truth, to this day we may find among ourselves some survivals of the old superstitions still lingering in out-of-the-way corners. Thus it is only a few years since the skull of a suicide was used in Caithness as a drinking-cup for the cure of epilepsy. Dr. Arthur Mitchell knows of a case in which the body of such a one was disinterred in order to obtain her skull for this purpose.

It was, however, accounted a more sure specific for epilepsy to reduce part of the skull to powder and swallow it. Even the moss which grew on such skulls was deemed a certain cure for various diseases. Nor was this simply a popular superstition. In the official Pharmacopœia of the College of Physicians of London, A. D. 1678, *the skull of a man who has died a violent death*, and the horn of a unicorn, appear as highly approved medicines. Again, in 1724, the same pharmacopœia mentions unicorn's horn, human fat, and *human skulls*, dog's dung, toads, vipers, and worms, among the really valuable medical stores. The pharmacopœia was revised in 1742, and various ingredients were rejected, but centipeds, vipers, and lizards were retained.

Nor were these strange compounds prepared for human subjects only. In the "Angler's Vade Mecum," published in 1681, anglers are recommended to use an ointment for the luring of fish, consisting, among other horrible ingredients, of *man's fat*, cat's fat, heron's fat, asafœtida, finely powdered mummy, camphor, oil of lavender, etc.; and it was added that man's fat could be obtained from the London chirurgeons concerned in anatomy.

Of ordinary skulls, multitudes are known to have been exported from Ireland to Germany for the manufacture of a famous ointment. But as regards the more precious skull of the sinner who has died by his own hand, some faith in its efficacy seems still to linger in various parts of Britain. The Rev. T. F. Thiselton Dyer quotes an instance of it in England in 1858; and some years later, a collier's wife applied to the sexton at Ruabon in Wales for a fragment of a human skull, which she purposed grating to a fine powder, to be mixed with other ingredients as a medicine for her daughter, who suffered from fits. Scotland likewise furnishes a recent instance of the same strange faith, which about thirty years ago happened to come under the notice of Sir James Simpson, in the parish of Nigg in Ross-shire, where, a lad having been attacked with epilepsy, which his friends vainly sought to cure by the charm of mole's blood (the blood of a live mole being allowed to drip on his head), they actually sent a messenger nearly a hundred miles to procure a bit of the skull of a suicide.

This treasure was scraped to dust and mixed with a cup of water, which the boy, ignorant of its contents, was make to drink! (An equally odd cure for consumption was, not long ago, fully believed in in the adjoining county of Sutherland, where the patient was made to drink warm blood drawn from his own arm. An instance of this was related to Sir James Simpson by one of the parties concerned. Dr. Mitchell has seen several epileptic idiots who had been subjected to the same treatment.)

Equally precious to the leech of the last century were the ashes of a burned witch collected from her funeral-pyre. Such were deemed a certain cure for gout or for fever, and eagerly were they gathered up and treasured.

Whatever may have been the special merit thus attaching to criminals (and we know that a strand from the rope with which a man had been hanged was long accounted an amulet against many ills), it is satisfactory to know that saints have had their share in this dubious honor. There is one sect of our fellow-Christians in Syria, namely, the Nestorians, who, while they eschew all veneration for relics, yet believe the remains of saints and martyrs to be endowed with such supernatural virtues, that at their wedding-feasts the dust of some reputed saint is invariably mixed with the wine in the marriage-cup—a custom which would seem to require numerous additions to their saintly calendar. Doubtless, however, the holy dust multiplies, that the supply may be equal to the demand.

But to return to this remarkable phase of cannibalism in Europe, we find that, just as the Chinese doctor sets most store by the animals imported from foreign lands, so did our ancestors chiefly prize a preparation of long-deceased Egyptians. Among the standard medicines quoted in the medical books of Nuremberg of two hundred years ago are "portions of the embalmed bodies of man's flesh, brought from the neighborhood of Memphis, where there are many bodies that have been buried for more than a thousand years, called *mumia*, which have been embalmed with costly salves and balsams, and smell strongly of myrrh, aloes, and other fragrant things." The writer further tells how, "when the sailors do reach the place where the mumia are, they fetch them out secretly by night, then carry them to the ship and conceal them, that they may not be seized, because certainly the Egyptians would not suffer their removal." Nevertheless, the sailors had no great liking for their cargo, believing it to be connected with unholy magic, and that ships having mummies on board would assuredly meet with terrible storms, and very likely be compelled to throw them as an offering to the angry waves.

These medicinal mummies were also imported from Teneriffe, where in olden days the natives used to embalm their dead, sew them in buckskin shrouds, and hide them in caves, whence they were stolen by traders. "White mummies" were also obtained from the coast of

Africa, where bodies of drowned mariners were sometimes washed ashore, and became dried up and shriveled as they lay unburied on the burning sands. These became so light as scarcely to weigh thirty pounds. They were, however, not considered so desirable as the genuine article from Alexandria, and were, moreover, more expensive.

The learned doctors of France, Germany, and Italy all made great use of this eccentric drug, and in the seventeenth century grievous complaints arose of its adulteration. Monsieur Pomet, chief apothecary to the French king, records that the king's physician went to Alexandria to judge for himself on this matter, and, having made friends with a Jewish dealer in mummies, was admitted to his storehouse, where he saw piles of bodies. He asked what kind of bodies were used, and how they were prepared. The Jew informed him that "he took such bodies as he could get, whether they died of some disease or of some contagion ; he embalmed them with the sweepings of various old drugs, myrrh, aloes, pitch, and gums, wound them about with a cere-cloth, and then dried them in an oven, after which he sent them to Europe, and marveled to see the Christians were lovers of such filthiness."

But even this revelation did not suffice to put mummy-physic out of fashion, and we know that Francis I, of France, always carried with him a well-filled medicine-chest, of which this was the principal ingredient.

Old Sir Thomas Browne, after enumerating the various diseases for which divers great doctors recommend mummy as an infallible remedy, protests against such unworthy use of the ancient heroes, and declares that to serve up Chamnes and Amosis in electuaries and pills, or that Cheops and Psammetichus should be weighed out as drugs, is dismal vampirism, more horrible than the feasts of the ghouls.

The apothecaries of England were often well content to make use of a cheap substitute which answered quite as well, namely, the bones of ancient Britons. Dr. Toope, of Oxford, writing in 1685, tells how at the circles on Hakpen Hill, in Wiltshire, he had discovered a rare lot of human bones—skeletons, arranged in circles, with the feet toward the center. He says, "The bones were large and nearly rotten, but the teeth extream and wonderfully white." Undisturbed by any questions of reverence for these ancestors of his race, he adds "*I dug up many bushells, with which I made a noble medicine.*"

The mummy-trade was supported by various classes of the community, for artists declared that mummy-powder beaten up with oil, gave richer tones of brown than any other substance, and modern perfumers found means of preparing the perfumes and spices found inside the bodies, so as to make them exceedingly attractive to the ladies. Paper-manufacturers found that the wrappings of the mummies could be converted into coarse paper for the use of grocers, and the cloth and rags were sometimes used as clothing—at least, so we are told by Abdallatif, a traveler of the twelfth century, who also records how one of his friends found in the tombs of Ghizeh a jar carefully sealed, which he opened, and found it to contain such excellent honey that he could not resist eating a good deal of it, and was only checked in his feast by drawing out a hair, whereupon he investigated further, and found the body of an ancient Egyptian baby in good condition, and adorned with jewels. He does not record how he enjoyed that meal in retrospect. Imagine dining off the honeyed essence of a baby-Pharaoh !

Is it not pitiful to think that all the skill so lavishly expended by the sages of ancient Egypt in rendering their bodies indestructible, should, after three thousand years, end in this ? And, in truth, the mummies thus dealt with, had less reason to complain of their lot than the multitude which were broken up and sold at so much per ton to fertilize the fields of a far-distant and insignificant islet peopled by barbarians !

A very interesting point of similarity between the little shop of the old Japanese apothecary, and those of early English druggists, is suggested by the extensive use of calcined animal matter, recommended in the prescriptions which were most highly valued in England before the Norman Conquest, and which are recorded in elaborate Saxon manuscripts, carefully preserved in our national archives. These " leechdoms " are written in ancient black-letter characters, and are curiously illustrated with pictures of the herbs and animals which are recommended for medicinal use.

Our Saxon ancestors appear to have devoted considerable attention to the subject of their hair. Though ignorant of macassar-oil, they discovered that dead bees burned to ashes, and seethed in oil with leaves of willow, would stop hair from falling off ; but should the hair be too thick, then must a swallow be burned to ashes under a tile, and the ashes be sprinkled on the head. But in order altogether to prevent the growth of hair, emmets' eggs rubbed on the place are found an effectual depilatory ; " never will any hair come there."

Excellent also as a cure for deafness is the juice of emmet's eggs crushed, or else the gall of a goat, or, in extreme cases, boar's gall, bull's gall, and buck's gall, mixed in equal parts with honey, and dripped into the ear, sometimes with the addition of very nasty ingredients. But if earwigs had entered in, then the sufferer is bidden to " take the mickle great windlestraw, with two edges, which waxeth in highways, chew it into the ear ; he, the earwig, will soon be off."

Even this poor insect was turned to account. One prescription desires that " the bowels of an earwig be pounded with the smede of wheaten meal and the netherward part (i. e., root) of marche, and mingled with honey."

For a hard tumor or swelling, goat's flesh burned to ashes and smudged on with water is found to be efficacious, as are also shavings off the horn of a hart to disperse ill-humors and gatherings. Wood-ashes seethed in resin, or goat's horn burned and mingled with water, or its dung dried and grated and mingled with lard, were all good remedies for swellings.

For erysipelas, the prescriptions are numerous. A plaster of earth-worms, or of bullock's dung, still warm is recommended; but, better still, "For that ilk, take a swallow's nest, break it away altogether, and burn it, with its dung and all; rub it to dust, mingle with vinegar, and smear therewith." For pain of jowl, burn a swallow to dust, and mingle him with field-bee's honey. Give the man that to eat frequently.

To the value of every portion of a fox not even the fairy-lore of Japan can bear higher testimony. The man who has disease of the joints is advised to take a living fox and seethe him till the bones alone be left, and then bathe repeatedly in this foxy essence. And every year he shall prepare himself this support, and let him add oil thereto, when he seetheth him. Wonderfully it healeth!

For sore of ears and dimness of eyes, a fox's gall mingled with oil or with honey is recommended, and "the fat of the fox's loin melted and dropped in the ear also bringeth health. For oppressive, hard-drawn breathing, a fox's lung sodden and put into sweetened wine and administered, wonderfully healeth." A salve of fox's grease mingled with tar would heal all manner of sores, while his liver worked cures quite as notable as those recorded in Japan. Shoes lined with vixen-hide were recommended to those who suffered from foot-addle—i. e., gout.

Next in value to the fox ranks the hare, whose brain drunk in wine "wonderfully amendeth" an indolent tendency to oversleep. Its lung, bound on the sore, healeth both eyes and feet. The hare's gall, mingled with honey, brighteneth the eyes. The lung and liver, mingled with myrrh and boiled in vinegar, cures giddiness. The sinews swallowed raw are an antidote against bite of spiders; and the rennet administered in wine against that of serpents. The heart mingled with dust of frankincense heals various forms of disease, while baldness is averted by smearing the head with oil in which have been seethed portions of this poor little animal. "Then the hair holdeth on, and the salve compels that it shall grow."

If the gums of a child be frequently rubbed with a hare's brain sodden, then shall its teeth wax without sore. The milk of a she-wolf was held equally efficacious, but more difficult to obtain!

Next in order of merit comes the he-goat, whose liver pounded with vinegar is found valuable as a styptic, as is also his blood dried and reduced to dust; goat's gall is a cosmetic which will remove all unsightly spots and specks from off the face; mingled with apple-juice it heals diseases of the ear, or, with oil, is a remedy for toothache. If a child be epileptic, "draw the brain of a mountain-goat through a golden-ring; give it to the child to swallow before it tastes milk; it will be healed." "To get sleep, a goat's horn laid under the head turneth waking into sleep." A goat's horn, roasted and pounded with acid, reduces the inflammation of erysipelas. Goat's grease and blood mingled with barley-meal forms a soothing poultice, while pills of goat's grease and a draught of its blood are recommended for dropsy.

Many and indescribably disgusting are the other remedies derived from the goat. A Brahman, reverentially swallowing a little of each product of the sacred cow, would shrink with loathing from the leechdoms of the early English, so important a place do they assign to preparations of the excrement of divers animals, but chiefly of bulls, of swine, of dogs, and of goats. These, and many other foul ingredients are compounded in every conceivable manner, and prescribed not merely for medicinal baths and plasters for external use, but as most unsavory physic for the inner man.

A less nasty remedy was bull's marrow, administered in wine to check spasms, while its gall was prescribed for divers diseases; moreover, it was well known that snakes would flee from any place where a bull's horn, burned to ashes, had been sprinkled.

The brain, lung, and liver of the boar are largely prescribed, while for nausea "boar's suet boiled down, and with boar's foam added thereto, is so sure a remedy that the patient will wonder, and will ween that it be some other leechdom that he drank." A pleasant cure for sleeplessness is to lay a wolf's head under the pillow; while wolf's flesh, well seasoned, counteracts devil sickness and an ill-sight. A draught of wolf's milk, mingled with wine and honey, was a potent remedy for women in dire suffering; while an ointment made from the right eye of a wolf was the best prescription that the Saxon oculist could command. The head-bone or skull of a wolf, when burned thoroughly and finely pounded, would heal racking pain in the joints, and the ashes of a swine's jaw are to be laid on the bite of a mad dog.

Truly valuable was lion's suet, of which it is stated "it relieveth every sore." Elephant bone or ivory, pounded with honey, is an infallible cosmetic, removing all blemishes from the face. "For the kingly disease, jaundice, the head of a mad dog, pounded and mingled for a drink with wine, healeth. For cancer, the head of a mad dog, burned to ashes and spread on the sore, healeth the cancer-wounds; while, for laceration by a mad dog, a hound's head burned to ashes, and thereon applied, casteth out all the venom and the foulness, and healeth the maddening bites." "For pain of teeth, burn to ashes the tusks of a hound; sprinkle the dust in wine, and let the man drink. The teeth shall be whole."

Another effectual remedy, for cancer, is to burn a fresh hound's head to ashes and apply to the wound. Failing relief, human excrement, dried and reduced to dust, may be tried. "If, with this, thou art not able to cure him, thou mayest never do it by any means!"

An excellent remedy for imperfect sight was an ointment of honey mixed with the fatty parts of all manner of river-fishes. Another, equally efficacious, was a compound of dumbledore's honey with the ashes of burned periwinkle. It was, however, requisite that certain mystic words should be uttered while gathering the periwinkle, a wort which had special power to counteract demoniacal possession and devil-sicknesses. The ashes of the elder-tree were applied in cases of palsy, for which a plaster of earth-worms, well pounded, is also accounted excellent.

We may well believe that, for convenience' sake, many of these calcined plants and animals were prepared at leisure and stored, ready for use in cases of emergency. Consequently, though we can hardly flatter ourselves that our ancestors were as exquisite in their neatness as the Japanese, doubtless this little druggist's shop in Osaka gives us a very fair notion of the surroundings of a learned Saxon leech, in whose repositories were earthenware jars of every size, containing the ashes of goat's flesh, of dead bees, of wolf's skull or swine's jaw, of divers shell-fish, of worts and rinds without number—nay, even of human skulls and bones. On the walls hung bunches of dried herbs and remains of birds and lizards, rats, moles, and such small deer, together with skins of serpents, portions of mummies, horns of stags, rhinoceros, narwhal, elephants' tusks, and many other items of the strange materia medica of our own ancestors.

The foregoing "leechdoms" are fair samples of the voluminous pharmacopœia of Britain in the tenth century. But to us, who pride ourselves on the medical skill of the present day, it is truly marvelous to find that *the early part of the eighteenth century should show so little, if any, advance on the ignorance which prevailed at the date of the Norman Conquest.* Here is a rare old volume which was printed in the Cowgate of Edinburgh in 1712. It is "A Collection of useful Remedies for most Distempers. . . . Collected by John Moncrief, the laird of Tippermalluch, a person of extraordinary skill and knowledge in the art of physick, and who performed many stupendous cures by these simple remedies."

His volume contains innumerable directions for the preparation of divers herbs, and also a multitude of prescriptions of animal substances so inexpressibly loathsome as to make it a matter of marvel how any one could be found either to prepare them, or to submit to their application. Salts of ammonia in the crudest form were a favorite remedy for external or internal use.

By far the least objectionable compounds were those prepared from carbonized animals in the Japanese or early Saxon manner. Thus "for a dangerous squinance or quinsy" Tippermalluch bids his disciples—

Take old Swallows, and burn them in a pot, take the powder thereof and mix it with Honey and anoint the Throat therewith. A plaister of a Swallow's Nest dissolves humours of the Gorge and Chouks. Ashes of worms applyed with honey draws out little broken bones.

For falling of the hair. Make a Lee of the Ashes of Cow's Dung, wherewith wash the Head. The burnt Ashes of little Froggs applyed cures the falling of the hair, called Alopecia. The burnt Ashes of Goats Dung mixt with Oyl, anointed, multiplys the Hair. The Ashes of a Goat's Hoof mixed with Pitch healeth the Alopecia. The Ashes of Bees mixt with Oyl, or the ashes of Southernwood mixt with old Oyl, causeth hair to grow. A Lee of the Ashes of Ivic-tree-Bark causeth hair grow yellow. The Blood of a shell Crab anointed, breeds much hair. But the Blood of a Bat, or a little Frog, the powder of a Swan's Bones, or the Milk of a Bitch hinders the growing of the hair. The bark of the Sallow Tree dissolved in Oyl maketh the hair black. The decoction of the flowers of broom dye it yellow. To make Curl'd hair. Ashphodele roots rubbed on the head, the same being first raz'd (i. e., shaven).

For the cure of the disease called Lethargie burn the whole skin of a Hare, with the ears and nails, and give the patient the powder thereof warm. The smoak of Kid's leather burnt, holden to the Nose, awakens them powerfully. Ashes of Hartshorn burnt, mixt with the Oyl of Roses and anointed on the forehead and temples, causeth a pleasant sleep.

For Cancer, the Ashes of a Dog's head, or burnt human dung.

The Ancle-bones of a Swine or the hoofs of a Cow, burnt and drunk, cures the Colick. Hare's blood fryed, taken, Rosted Hare's flesh eaten, the Ashes of a Hare, burnt whole, Ashes of burnt willow, or Ashes of the bark of the Elm-tree cureth burning or scalding. Powder of the burnt hairs of a hare cures St. Anthonies Fire, i. e., Erysipelas.

Here are valuable styptics to stanch bleeding of the Nose. Make a powder of the blood of the Patient after it is burnt, and blow it up in the Nose. It powerfully stays the bleeding. Snails with the shells bruised, put in. Juice of Swine's dung, put in. Hold before your eyes the herb sheepherd's scrip, or Vervain, or Knot-grass. *These herbs have that propertie, by looking on them, to stanch blood.*

Ashes of a Frog well burnt in a Pot, gleweth Veins and Arteries and cures Burning. Ashes of Hen's feathers burnt, or ashes of Nettles snuffed up. The blood of a Partridge, of an Ozell, of a Dove, applyed, stayeth the flowing of the blood most healthfully. The blood of a Cow put in the wound.

Cause the patient to ly on his back all naked, and drop on his Face Water and Vinegar. This is a most sure Cure. Steep a Hare's hair in Water and Vinegar, put it in the Nose and it will produce a marvellous effect.

Or take a Toad, dry it very well before the Sun, put it in a Linnen cloath and hang it with a string about the party that bleedeth. Let it touch the breast of the Left side near the Heart. Spiders pulverised and snuffed stops blood.

I think the Japanese gentleman who was so much annoyed at my having obtained a glimpse of "the foolishness" of old Japanese medicine, might have wondered a good deal had he got hold of some English prescriptions of the last century!

From an almost endless catalogue of healing-spells which are *to* *this day* practiced by the peasantry of various districts in England and Scotland, I will quote a few which are considered certain remedies. The Northumbrian cure for warts is to take a large black snail, rub the wart well with it, and then impale the poor snail on a thorn-hedge. As the poor creature wastes away, the warts will surely disappear.

In the west of England eel's blood serves the same purpose. For goître or wen a far more horrible charm must be tried. The hand of a dead child must be rubbed nine times across the lump, or, still better, the hand of a suicide. It is not many years since a poor woman living in the neighborhood of Hartlepool, acting on the advice of a "wise woman," went alone by night to an out-house where lay the corpse of a suicide awaiting the coroner's inquest. She lay all night with the hand of the corpse resting on her wen; but the mental shock of that night of horror was such that she shortly afterward died.

In the neighborhood of Stamfordham, in Northumberland, whooping-cough is cured by putting the head of a live trout into the mouth of the patient, and letting the trout breathe into the child's mouth. Or else a hairy caterpillar is put in a small bag and tied round the neck of the child, whose cough ceases as the insect dies.

A peculiar class of remedy is that of making offerings of hair as a cure for whooping-cough. In Sunderland, the crown of the head is shaved, and the hair hung upon a bush or tree, in full faith that, as the birds carry away the hair, so will the cough vanish. In Lincolnshire, a girl suffering from ague, cuts a lock of her hair, and binds it round an aspen-tree, praying it to shake in her stead. In Ross-shire, where living cocks are still occasionally buried as a sacrificial remedy for epilepsy, some of the hair of the patient is generally added to the offering. And at least one holy well in Ireland (that of Tubber Quan, near Carrick-on-Suir) requires an offering of hair from all Christian pilgrims who come here on the last three Sundays in June to worship St. Quan; part of the ceremonial required is that they should go thrice round a neighboring tree on their bare knees, and then each must cut off a lock of his hair, and tie it to a branch as a charm against headache. The tree, thus fringed with human hair of all colors, some newly cut, some sun-bleached, is a curious sight, and an object of deep veneration.

Travelers who remember the tufts of hair which figure so largely among the votive offerings in Japanese temples, may trace some feeling in common between the kindred superstitions of these Eastern and Western isles.

Hideous is the remedy for toothache practiced at Tavistock in Devonshire, where a tooth must be bitten from a skull in the churchyard, and kept always in the pocket.

Spiders are largely concerned in the cure of ague. In Ireland the sufferer is advised to swallow a living spider. In Somerset and neighboring counties, he is to shut a large black spider in a box and leave it to perish ; while in Flanders he is to imprison one in an empty walnut-shell, and wear it round his neck. Even in sturdy New England a lingering faith in the superstitions of the old mother-country leads to the manufacture of pills of spider's web as a cure for ague, and Longfellow tells of a popular cure for fever "by wearing a spider hung round one's neck in a nutshell." This was the approved remedy of our British ancestors for fever and ague ; and I am told that in Sussex the prescription of a live spider rolled up in butter is still considered good in cases of obstinate jaundice.

Many and horrible are the remedies for erysipelas. Thus, at Loch Carron, in Ross-shire, we knew of a case in which the patient was instructed to cut off one half of the ear of a cat, and let the blood drip on the inflamed surface.

It appears that the old superstition may even survive in such an atmosphere of strong common sense as that of Pennsylvania, where so recently as the year 1867, a case was reported in which a woman was found to have administered three drops of a black cat's blood to a child as a remedy for croup. Her neighbors objected to her pharmacy, and proved their superior wisdom by publicly accusing her of witchcraft.

In Cornwall the shedding of blood is not required. The treatment prescribed for the removal of "whelks" or small pimples from the eyelids of children is simply to pass the tail of a black cat nine times over the part affected.

Of the burial of a living cock on behalf of an epileptic patient, we have had many instances in the north of Scotland in the present century, but this savors rather of devil-propitiation and sacrifice than of medicine-lore.

In Devonshire the approved treatment for scrofula at the present day is to dry the hind-leg of a toad and wear it round the neck in a silken bag, or else they cut off that part of the living reptile which answers to the part affected by scrofula, and, having wrapped the fragment in parchment, tie it round the neck of the sufferer. In cases of rheumatism, a "wise man" of Devonshire will burn a toad to ashes, and tie the dust in a bit of silk to be worn round the throat.

So recently as 1822, one of these quacks traveled through England "in his own gig." Each patient who consulted him was required to bring him a fee of seven shillings and a live toad. He pocketed the shillings and cut the hind-legs off the luckless toads, placing them in small bags, which he solemnly hung round the neck of the sufferer, who was required to wear this unfragrant appendage till the leg was quite decayed!

For the same malady the same remedy was in the last century recommended by a beggar-wife to a girl at Gaddesden who had been a sufferer from her infancy. It is stated that the cure was effected, and that the girl never suffered afterward. But it is worthy of note that the beggar-wife explained that the efficacy of the charm lay in the death of the poor mutilated toad, which, deprived of its legs, would pine and die, but as it slowly wasted so would the distemper pass away. Here, then, as in the offering of the live cock, was involved the principle of sacrifice—a life for a life.

Another girl in the same village was partly cured of the "evil" in her eyes by applying a sun-dried toad to the back of her neck, whereby blisters were raised. Poor toads are still made to do service in divers manners in Cornwall and Northampton for the cure of nose-bleeding and quinsy; while "toad-powder," or even a live toad or spider shut up in a box, is still, in some places, accounted as useful a charm against contagion as it was in the days of Sir Kenelm Digby. The medicine known to our ancestors as *Pulvis Æthiopicus* (a valuable remedy both for external and internal use in the treatment of small-pox and dropsy) was neither more nor less than powdered toad.

Frogs are well-nigh as valuable as toads to the sick poor, who are rarely lacking in the primary necessity of faith in the means adopted. Thus, frog's spawn, placed in a stone jar and buried for three months till it turns to water, has been found wonderfully efficacious in Donegal, when well rubbed into a rheumatic limb. How much of the credit was due to the rubbing is not recorded. In Aberdeenshire a cure recommended for sore eyes is to lick the eyes of a live frog. The man who has thus been healed has henceforth the power of curing all sore eyes by merely licking them! In like manner it is said in Ireland that the tongue which has licked a lizard all over will be for ever endued with a marvelous power of healing whatever sore or pain it touches.

Another Irish remedy is to apply the tongue of a fox to draw a troublesome thorn from the foot; the tooth of a living fox to be worn as an amulet is also deemed valuable as a cure for an inflamed leg. The primary difficulty is to catch the fox and extract his tooth!

With respect to deep-seated thorns, the application of a cast-off snake-skin is efficacious, not to attract the thorn toward itself, but to expel it from the opposite side of the hand or foot. But, once we touch on the virtues of the mystic snake, we find its reputation just as great in Britain's medicine folk-lore as in Japan, where the great snake-skins held so conspicuous a place in the druggist's shop, or in China, where the skin of a white-spotted snake is valued as the most efficacious remedy for palsy, leprosy, and rheumatism.

Strange to say, in the old Gaelic legends, there is a certain white snake who receives unbounded reverence as the king of snakes, and another legend tells of a nest containing six brown adders and *one pure white one*, which latter, if it can be caught and boiled, confers wondrous medical skill on the lucky man who tastes of the serpent-broth.*

In some of the Hebridean Isles, notably that of Lewis, the greatest faith prevails in the efficacy of so-called "serpent-stones," which are simply perforated, water-worn stones. Some have had two plain circles cut upon them. These are dipped in water, which is then given to cattle as a cure for swelling or for snake-bite. Should such a charmed stone be unattainable (and their number is exceedingly limited), *the head of an adder may be tied to a string and dipped in the water, with equally good result.*

The oft-quoted remedy, "A hair of the dog that bit you," appears in many forms. In Devonshire, any person bitten by a viper is advised at once to kill the creature and rub the wound with its fat. I am told that this practice has survived in some of the Northern States of America, where the flesh of a rattlesnake is accounted the best cure for its own bite.

In Black's very interesting volume on "Folk-Medicine," he mentions that the belief in the power of snake-skin as a cure for rheumatism still exists among the sturdy New-Englanders, some of whom are not above the weakness of wearing a snake-skin round the neck, or keeping a pet snake as a charm. The use by American Indians of rattlesnake-oil for the same malady seems not devoid of reason; but the New England faith in snake-skin is probably a direct heritage from Britain, where Mr. Black tells of an old man who used to sit on the steps of King's College Chapel, at Cambridge, and earn his living by exhibiting the common English snake, and selling the sloughs of snakes, to be bound round the forehead and temples of persons suffering from headache.

In Durham, an eel's skin worn as a garter round the naked leg is considered a preventive of cramp, while in Northumberland it is esteemed the best bandage for a sprained limb.

So, too, in Sussex, the approved cure for a swollen neck is to draw a snake nine times across the throat of the sufferer, after which operation the snake is killed, and its skin sewed in a piece of silk and worn round the patient's neck. Sometimes the snake is put in a bottle, which is tightly corked and buried in the ground, and it is expected that, as the victim decays, the swelling will subside.

The quaint little drug-store at Osaka has led me into a long talk; but the subject is a large one, and the chief difficulty lies in selecting a few examples from the mass of material before me. I am sure that should these pages ever meet the eye of my Japanese friend, he will acknowledge that my interest in the medicine-lore of his ancestors was certainly justifiable.—*Nineteenth Century.*

* See "In the Hebrides," by C. F. Gordon Cumming, London, Chatto & Windus.

# THE ECONOMIC DISTURBANCES SINCE 1873.

By Hon. DAVID A. WELLS, LL. D., D. C. L.

IV.

DEPRESSION of prices has, to a large extent, been accepted as a prime cause of the "economic disturbance" which has prevailed since 1873. Indeed, Mr. Robert Giffen, the well-known English economist and officer of the British Board of Trade, in an article contributed to the "Contemporary Review," June, 1885, does not hesitate to express the opinion that "it is clearly unnecessary to assign any other cause for the gloom of the last year or two;" and continuing, he further says:

"The point to which I would draw special attention is, that . . . the most disastrous characteristic of the recent fall of prices has been the descent all round to a lower range than that of which there had been any previous experience. It is this peculiarity which—more than anything else—has aggravated the gloom of merchants and capitalists during the last few years. Fluctuations of prices they are used to. Merchants know that there is one range of prices in a time of buoyancy and inflation, and quite another range of prices in times of discredit. By the customary oscillations, the shrewder business people are enabled to make large profits, but during the last few years the shrewder, as well as the less shrewd, have been tried. Operations they ventured on when prices were falling to the customary low level have failed disastrously, because of a further fall which is altogether without precedent. The change is more like a revolution in prices than anything which usually happens in an ordinary cycle of prosperity and depression in trade."

Here, then, is a description of the extent of the recent fall in prices, and its influence in producing and aggravating the gloom of merchants and capitalists, by one well competent to appreciate and describe what has happened. The point of novelty and greatest significance, however, in Mr. Giffen's statement is, not that a depression of prices has been productive of gloom and a depression of business—for no fact is better recognized by all economists and business men than that on a falling market trade is always stagnant, and that nothing is more productive of gloom to the industrial and mercantile community owning or carrying stocks of merchandise than losses experienced or anticipated through a fall in prices; but that the recent fall in the prices of the great staple commodities of the world has been in extent and character without precedent in the world's history.*

A further fact of the highest importance, and one that is not dis-

* "Many who discuss this question, and whose opinions generally command deference, appear scarcely to realize the enormous extent of the fall, and it is only by means of very extensive statistics and of a comparison of various periods that a clear insight into the details and a broad view of the whole can be gained."—Augustus Sauerbeck *Journal of the Statistical Society of London, September, 1886.*

puted, is, that no peculiarity of currency, banking, or standard of value, or form of government, or incidence and degree of taxation, or military system, or condition of land tenure, or legislation respecting trade, tariffs and bounties, or differences in the relations between capital and labor in different countries, has been sufficient to guard and save any nation from the economic disturbances or trade depression which has been incident to such changes in prices.

An analysis of British exports and imports for 1886, with comparisons of similar data for the previous year, 1885 (presented by the "London Economist" in its issues for January 22 and 29, 1887), furnishes, moreover, some information, almost, if not fully, in the nature of a demonstration of the continued tendency of prices to decline during the latest period for which accurate data are (at present) accessible, and also of the continued universality of such tendency. Thus, looking first at exports, it appears that there was an increase during the year 1886 in the quantities of British and colonial commodities exported of 6·02 per cent, as compared with similar aggregates for 1885; or Great Britain sent out 106,020 pounds, tons, or other quantities in 1886, in place of 100,000 in 1885. Comparing, however, the sum which the quantities actually exported in 1886 would have cost at the prices of 1885, a decline in price is indicated of 6·34 per cent; or while sending away 106,020 pounds, tons, or other quantities in 1886, as compared with 100,000 in 1885, Great Britain received back in money value only $93,660 for the same quantities which in the previous year brought $100,000.

"A similar examination of British imports for 1886 also brings out the further interesting fact that the average decline in the prices of the goods imported was almost precisely the same as in prices of goods exported. The increase in quantities of imports was less than one per cent; or the country brought in 100,796 pounds, tons, or other quantities, in place of 100,000 in 1885. But the decline in prices was 6·373 per cent; so that the country paid only $93,627 for the same quantities for which it paid $100,000 in the previous year. The decline in the general range of prices for the year 1886, as measured by the actual exports and imports of the greatest exporting and importing nation of the world, would therefore appear to have been in excess of six per cent; and this decline would seem to have occurred during the same period in all those countries in which Great Britain deals as a seller equally with those in which she deals as a buyer; or, in other words, this decline was practically universal." *

The question which here naturally suggests itself, as to what in general has been the extent of the recent fall in prices, is perhaps best answered from the basis of English figures, by Mr. Augustus Sauerbeck, who, as the result of an exhaustive inquiry into the price movements of thirty-eight leading articles of raw produce since 1818–'27

* New York Commercial Bulletin.

(communicated to the Statistical Society of London and published in the journal of their "Proceedings" for September, 1886, and March, 1887), has arrived at the following conclusions: There was a persistent decline in the average prices of general commodities in England from the beginning to the middle of the present century; or, more exactly, to 1849. From thence there was an advance, which culminated in 1873. But leaving out of consideration a remarkable speculative period from 1870 to 1874, coincident with the Franco-German War and the payment of the war indemnity by France, during which period prices rose with great rapidity from 1870 to 1873, and fell in the succeeding year (1874) below their average starting-point in 1870, the decline of prices may be regarded as having been continuous from 1864 to 1886. Compared with the average prices of general commodities from 1867–'77, the period from 1878–'85 shows a depreciation of 18 per cent. But if the average prices of 1885 alone be taken, the decline from the average for 1867–'77 is 28 per cent; or continuing the comparison through 1886 and embracing a somewhat larger number of articles, the average depreciation, in the opinion of Mr. Sauerbeck, has amounted to 31 per cent. Furthermore, the average level of prices for 1886, according to the tables of Mr. Sauerbeck, was considerably below the average for the year 1848, which in turn appears to have been the lowest previous point for the century subsequent to 1820.

Many similar inquiries, embracing in some instances a much larger number of articles than were selected by Mr. Sauerbeck, have been instituted in recent years by other investigators in England, France, Germany, and the United States; but the conclusions arrived at are respectively so divergent that no figure representing the average decline during the period under investigation would probably be universally accepted as in every way satisfactory and conclusive.*

The usual method employed by European economists in order to form a correct idea of the changes of prices in one period as compared with another, is to take the prices of certain selected commodities in a given year, or the average prices of a series of years, as the standard; represent this by the figure 100 or 1,000, and then note the increase or decrease in price in the case of each article in each subsequent year in proportion to this standard. Combining the percentage of price alterations among all the articles, a total of the variations experienced becomes known, and the number thus obtained is termed an *index number* for the year, or other period under consideration; or a number expressive of the ratio of price at a given date to the average of some former period. Thus, for example, if the average prices of forty articles in the year 1880 were to be taken at

* The so-called "Hamburg" tables published by the well-known German statistician, Dr. Soetbeer, in 1886, make the average of prices in 1885 10 per cent higher than they were in 1847–'50.

100, and the average decline in the prices of these same articles for the year 1810 was found to be 20 per cent, the index number for the year 1800 would be 100, and for the year 1810, 80.*

The difficulties in the way of obtaining satisfactory averages from comparisons of prices at different periods by the above or any other methods are, however, almost insuperable ; so that it may well be doubted whether the determination of an average of general prices is ever within the bounds of possibility. Quotations for a given day, or month, do not necessarily show the average for the year ; and, in like manner, the selection of a limited number of articles for comparison can not insure correct conclusions respecting the movement of prices in general. All methods of comparing price variations which content themselves with mere average quotations of different articles, and which do not pay due regard to the relative importance of each article in the domestic and foreign commerce of a country ; which, for example, allow a change of 80 per cent in the price of an article like cochineal, of which the value sold in any one year is small, to balance a change of 2 per cent in an article, like sugar, the value of which annually sold is enormous, are also in a great degree deceptive and worthless ; † and even when in the comparison of prices, the importance of considering relative quantities is fully recognized, the data for ascertaining these relations are extremely uncertain and questionable. The utmost of service that all such tabular comparisons of prices, even when prepared with all desirable qualifications, are capable of rendering, would, therefore, seem to be limited to the affording of important inferences respecting variations of prices, or to the showing

* For a full exhibit and discussion of these tables, reference is made to a paper prepared and laid before the British Royal Commission (third report, Appendix B, pp. 312–390, 1886), by R. H. Inglis Palgrave, F. R. S.; and also to an article in the (Harvard) "Quarterly Journal of Economics" (vol. i, No. 3, Boston, 1887), by Professor J. Laurence Laughlin, Professor of Political Economy, Harvard University.

† One of the best-known tables of this character, embracing twenty-two different articles, has been kept by the London "Economist" for many years as a constituent element of current British commercial history; and the objections inherent in the system adopted are forcibly illustrated by the following recent occurrence, to which attention has been called by the "New York Commercial Bulletin": Thus, a comparison of index numbers for January and July, 1886, and for January, 1887, as deduced from the "Economist's" tables of prices, indicated a small advance for the latter month in the general level of British prices. But the first article on the "Economist's" list of prices is coffee, which advanced from July 1, 1886, to January, 1887, to a degree sufficient to alone add 50 to the index number of January; while the entire increase for the whole twenty-two articles was only 36; or, in other words, if coffee alone were omitted from the list of articles compared, the net result would show an apparent decline instead of any advance in the general level of prices. "Certainly," as the "Commercial Bulletin" remarks, "it is difficult to attach much importance to results having no better basis than this. For coffee is by no means one of the most important articles compared; it is greatly exceeded in importance by at least twelve of them. But the change in that one article happens to have been surprisingly great, and it thus outweighs far more important changes in other articles, such as iron or meats."

whether a pound sterling or a dollar would have bought more or less of a given number of bushels, yards, or pounds at one time than another. In all other respects they are little other than curiosities; inasmuch as if some articles in a given period have risen and others have fallen in price, and if the fall of some and the rise of others can be undoubtedly traced to the action of entirely different causes, the grouping of these facts into the form of tables, and the endeavor to reduce the sum of the respective changes to a common average, can prove nothing whatever as to the cause or causes which have been operative in producing the changes. And between such discordant results effected by entirely diverse influences, there would, furthermore, seem to be no possibility of establishing an average; for the price of some articles, whose use has been superseded or impaired by change of fashion or new inventions, may fall nearly or quite to zero, while the price of others, by reason of increased demand or interrupted supply, may rise almost to infinity by comparison; and between such extremes there may be any number of gradations.

All, therefore, that can be confidently affirmed in respect to the extent of the recent depression of prices is, that comparing the data for 1885–'86 with those of 1866–'76, the decline has been extraordinary and has affected most articles and most countries; and that the estimate of Mr. Sauerbeck (before referred to), of 30 per cent as the average measure or extent of the decline, is not excessive.

It seems almost unnecessary to remark, that a fall of prices, although commonly so considered, can not, in any comprehensive discussion, be regarded as in any sense a primary cause of economic disturbances; but that here again something antecedent in the nature of a cause or causes, more or less general, must be sought for in explanation. And of such causes, two only that are worthy of attention have been suggested: *First,* a great multiplication and cheapening of commodities through new conditions of production and distribution, which in turn have been mainly due to the progress of invention and discovery; and, *second,* that the precious metal used for standard money, viz., gold, has, through relative scarcity, owing to diminished production and increased demand, greatly appreciated in value; in consequence of which a given amount of gold buys more than formerly; or, what is the same thing, the price or purchasing power of commodities, in comparison with gold, has fallen.

As to which of these two causes has been most influential in occasioning the recent great decline in prices, the best authorities who have investigated the subject, as is well known, widely differ. It is also well recognized that the determination of this question is almost fundamental in the so-called bimetallic controversy; the plea for an increased use of silver as money being wholly predicated on an alleged insufficiency in the supply of gold for effecting the world's exchanges, while ample evidence of the scarcity of gold is claimed to be found in the remarkable fall of prices which has been recently experienced. It is, however, a universally accepted canon, alike in logic and common sense, that extraordinary and complex agencies should never be invoked for the explanation of phenomena, so long as ordinary and simple ones are equally available and satisfactory for the same purpose. And with this premise, it is a matter of the highest interest and importance to observe how, with very few exceptions, the phenomenal decline in recent years of the prices of the world's great staple commodities admits not only of a ready and complete explanation in accordance with the first cause, but is, in fact, in the nature of an inevitable sequence from it; and, in support of this proposition, attention is asked to the nature of the agencies which have been so identical, absolute, and exclusive in determining the recent decline of prices in the case of such a number of what must be regarded as typically staple commodities, that their conjoined experiences would seem so fully to establish a rule, as almost to compel all antagonizing results, especially in the case of products of minor importance, to be regarded in the light of unimportant exceptions.

What these agencies have been, how they have acted, and what disturbing influences they have exerted on the world's prices, on the world's industries, commerce, and consumption, and on pre-existing relations of labor and capital, will, when fully told, constitute one of the most important and interesting chapters of political economy and commercial history. Such a complete statement it is not at present proposed to attempt; but the following exhibit of results, derived from a study of what may be termed the recent production and price experiences of a considerable number of important commodities, will, it is thought, better contribute to an understanding of the situation, and to a solution of the difficult economic problems involved in it, than any other method hitherto adopted.*

The commodity of prime importance in the commerce and consumption of the world, which appears to have experienced the greatest recent decline in price, is *sugar*, which has fallen to a lower rate than has ever been known in the history of modern commerce; the wholesale price of fair refining sugars having been more than 114 per cent higher in 1880 than in the first half of the year 1887.†

Now, while improved methods of manufacture and greater and

* "A general movement in prices is the resultant of a number of particular movements, and in these particular movements, again, we find the proximate causes of the distribution of the industrial forces of the world and of the wealth which these forces create."—PROFESSOR NICHOLSON, *University of Edinburgh, etc.*

† How continuous and regular has been the decline in the price of sugars in recent years is shown by the following table, which exhibits the average price of fair refining sugars in bond (or free of duty) in New York from 1880 to July, 1887, inclusive:

| | |
|---|---|
| 1880, 5·08 cents. | 1885, 3·06 cents. |
| 1882, 4·53 cents. | 1886, 2·92 cents. |
| 1884, 3·31 cents. | 1887 (lowest to July), 2·37½. |

cheaper facilities for transportation have undoubtedly contributed to such a result, it has been mainly due to an apparent desire, as M. Leroy-Beaulieu has expressed it, on the part of the Governments of France, Germany, Austria, Belgium, Holland, Italy, and Russia, "to make their national sugar industry the greatest in the world" by stimulating the domestic production of this commodity by the payment of extraordinary bounties on its exportation to other countries; or, in other words, by competing with one another in paying large sums for the purpose of speedily getting rid, at little or no profit, of one of the most valuable and highly-desired products of human industry.

On the other hand, in order to neutralize to some extent the exceptional advantages enjoyed through such an economic policy by the producers of beet-sugar in Europe, some of the cane-growing countries have felt obliged to encourage, by subsidies or tax-exemptions, their own sugar-production. In both Brazil and the Argentine Republic the manufacturers of cane-sugar have obtained a guarantee from the state of a five to six per cent return on their capital invested; while all the machinery needed in this industry may be imported free of duty. In the Spanish West Indies the home government has finally (1887) felt compelled to relinquish the export duties on sugars—the produce of Cuba and Porto Rico—which have long been regarded as almost indispensable on account of revenue necessities; while in South Africa and Australia the production of sugar has also been encouraged to such an extent that both of these countries will hereafter be undoubtedly included among the number of important sugar-exporting regions. In Central America, the British and Dutch West India Islands, Guiana, and India (which last produces more sugar than any other country) production has not as yet been artificially encouraged, and, with the exception of the levying of export taxes in certain localities, neither have any impediments been placed in the way of the natural growth of production. But at the same time it can not be doubted that the recent increased facilities for transportation and communication have, as before pointed out, been in the nature of a stimulus to the production of sugar, in common with all other commodities, and have opened up large and fertile sections of the earth, which a quarter of a century ago were practically inaccessible.

Under such conditions the increase in the production of sugar entering into the world's commerce, and available for general consumption, has been extraordinary. Mr. Sauerbeck estimates the increase from 1872–'73 to 1885–'86 to have been 68 per cent. Other authorities estimate the increase from 1853 to 1884, exclusive of the product of India and China, to have been at the rate of 30 per cent for each decade—or about 100 per cent compounded. In the Hawaiian Islands, where a remission of duties on sugars exported to the United States is equivalent to an export bounty of about 100 per cent, the domestic production of sugar has increased from about 12,000 tons in

1875 (the year before the duties were remitted) to 110,000 tons in 1886, an increase in eleven years of 750 per cent. The part that beet-root sugar has played in this increase is shown by the circumstance that while in 1860 the proportion of this variety to the whole sugar-product of the world (commercially reported) was less than 20 per cent, the product for 1886–'87 is estimated as in excess of 55 per cent; Germany alone having increased her product from about 200,000 tons in 1876 to 594,000 tons in 1880–'81, and to 1,155,000 tons in 1884–'85; while the increase of the beet-sugar product in the other bounty-paying states of Europe was not disproportionate.

Of this extraordinary increase of product, as large a proportion as foreign markets would take was, as a matter of course, exported in order to obtain the benefit of the government bounties on exports; the sugar-export of Germany alone increasing from about 500,000 cwt. in 1876 to over 6,000,000 cwt. in 1885, and, with every increase of exportation, the government disbursements on account of export bounties increased proportionally. The export bounty paid by Russia is estimated to have been as high at one time as $31.25 (£6 8*s.*) per ton; and that of France at between $35 and $40 (£7 and £8), entailing a present direct and indirect tax (French colonial sugars being admitted to the home market at reduced import rates), according to estimates recently presented by M. Dauphin, in the French Chamber of Deputies, of £3,280,000 ($16,400,000) per annum. In Germany the amount paid in the way of subsidies on sugar was estimated by Deputy Gehlert, in a speech in the German Reichstag in 1886, as having up to that time approximated $40,000,000; while for the year 1885, $10,000,000, it was claimed would be necessary, or an amount equal to the total wages paid to all workmen in all the German sugar-refineries. As might also have been expected, the profits of producers, and more especially of the sugar-refiners, working under the bounty (export) system, were at the same time enormously increased. In Germany the largest and best-managed beet-sugar manufactories divided for a series of years dividends to the extent of 60, 70, 90, and in one instance 125 per cent per annum on the capital invested; * and corresponding results were also reported in Austria, Russia, France, and Belgium. How rapidly and extensively sugar has declined in price, consequent upon such an extraordinary and unnatural increase in production, has already been

* "By a law passed in 1869 it was assumed that it took 12½ centners of beet-roots to give one centner of crude sugar, and a tax was levied on this basis, and a corresponding drawback allowed on exported sugar. Since then great improvements have been made in the process of manufacturing, so that but 10½ centners of roots are necessary to produce one centner of sugar instead of 12½ as formerly; but the Government continued to grant a drawback on the basis of 12½. The export drawback thus became an enormous premium to the producers, and the German manufacturers have been enabled to supply all Europe with cheap sugar; till, to protect themselves, the other states have had to increase their duties on the imports of foreign sugar."—*Report to United States Department of State by Commercial Agent* SMITH, *Mayence, January, 1887.*

pointed out. How much of disaster this decline has brought to great business interests and to the material prosperity, and even the civilization, of large areas of the earth's surface, will be made a subject of future notice.

Wheat.—The next important commodity to the recent production and price experiences of which attention will be asked, is wheat. The average price of British wheat for the last week in July, 1882, was 50*s.* per imperial quarter. For the corresponding dates for 1885 it was 32*s.* 11*d.*, and for 1886, 31*s.* 3*d.* per quarter ;* which last quotation was the lowest since average market prices have been officially recorded.†

The average price of wheat in the English markets for the decade from 1870 to 1880 was 43 per cent higher than the average of 1886 ; and the average prices from 1859 to 1872 were 68 per cent higher than the average of 1886.

An analysis of the comparative prices of wheat in the United States furnishes corresponding results ; the average price of No. 2 spring wheat having declined in the Chicago market from $1.10 (gold) in 1872 to 76½ cents in 1886 ; and 67 cents in July, 1887 ; a price equivalent to 29*s.* per quarter in the harbor at Liverpool, or 86 cents per bushel, cost, freight, insurance included. This is about the lowest price ever reported. The average annual export price of wheat for the whole country declined from $1.24 per bushel, in 1880, to 86·2 in 1885, and 87 in 1886. The average price of wheat in Chicago from 1872–'78 was $1.04 gold ; and the decline to the average price of 1886 was about 28 cents, representing a loss to the American producers of wheat on an average crop of at least $150,000,000 per annum. For such results an all-sufficient explanation would seem to be found in the circumstance, that all investigation shows that the comparatively recent increase in the world's supply of food has been greatly in excess of the concurrent increase of the world's population ; that there has been in the last decade a large increase in the area of land devoted to the cultivation of cereals ; an increase (due to better methods of tillage) in the average product per acre ; and an immense increase in the facilities for transportation, coupled with a greatly reduced cost, which has made product more accessible and accordingly more available for distribution. The most salient points of the evidence tending to these conclusions are as follows : The cereal production of the United States increased from 932,752,000 bushels in 1862 to 2,992,-881,000 in 1884 ; and in acreage from 34,594,381 to 136,292,766 ; or in the respective ratios of 452 and 338 per cent, respectively. The average wheat production of the United States for the five years from

* London "Economist."

† The Eton record gave only 26*s.* 9¾*d.* per quarter as the price for the year 1761, when reduced to Winchester bushels ; but there is no certainty that the average for the entire year was even in that one market as low as that, and still less that the price was as low in more than one hundred and fifty English market towns as it was in 1886.

1881 to 1885, inclusive, was 436,000,000 bushels; while for the ten years preceding—some of which supplied the heaviest demands for exportation ever experienced—the average was only 366,000,000 bushels. According to Mr. Neumann Spallart, a German statistician of repute, the production of cereals in Europe doubled from 1869 to 1879; and in the case of Russia, her exports of wheat increased from 36,565,000 bushels in 1880 to 67,717,000 in 1884. According to figures of the United States Bureau of Agriculture, the average production of wheat in Europe, for the five years from 1875 to 1881, inclusive, "increased some 50,000,000 bushels over the average of the ten years preceding, which included several seasons of unusually low yield in Western Europe." In 1862 the United States exported breadstuffs to the value of $24,000,000; in 1872 the corresponding value was $87,000,000; and in 1880, $288,000,000; and if since this latter year there has been a decline in the *value* of American cereal exports, it can not be attributed to any impairment of ability to produce and export, if sufficient inducements existed. Of the respective wheat-crops of the United States for the years 1884–'86, 30 per cent—in the form of wheat and flour—have been exported, the largest proportion ever recorded, except during the era of crop failures in Western Europe—i. e., 1878–1883. While, therefore, it is clear that the comparative product of the heretofore great wheat-producing countries has not diminished, recent experiences are also making it evident that the world is hereafter to derive important supplies of wheat from sources which a few years ago did not exist, or were regarded as of little importance. For example, British India, which in 1880 exported only 13,896,000 bushels, in 1885 exported 39,312,000 bushels, and whose increase of wheat exports appears to be coincident with the increase of the railway mileage of the country. During the same period Australia and New Zealand, where a rapid growth of population inevitably tends to divert agricultural industry from wool-producing to wheat-growing, increased their exports from 13,999,000 bushels in 1880 to 19,466,000 in 1885; and the Argentine Republic, from 5,772 bushels in 1881 to 3,986,000 in 1884. All the indications are, furthermore, that the increase of wheat supplies from new sources is likely to be continuous and of great magnitude: from India, whose internal and foreign commerce is yet only in its infancy, but is developing with extraordinary rapidity under the influence of railroad construction;* from the great wheat region of Manitoba, to

* "There is nothing more remarkable in the history of railway enterprise than the development of the traffic that has occurred on Indian railways within the last ten years, to go no farther back. In 1876 the total quantity of goods-traffic carried on all the railways of India was 5,750,000 tons. In 1886 the quantity was about 19,000,000 tons. In the year 1876 the mileage open was 6,833 miles, so that the volume of goods-traffic carried per mile was about 800 tons. In 1886 the mileage open was 12,376, so that the average volume of traffic carried per mile was over 1,500 tons. The aggregate volume of traffic in the interval had fully trebled, and the average traffic carried per mile open

open which the Canadian Pacific railroad was mainly constructed; from Algeria and Northern Africa, which, once the granaries of the Roman world, are now, for the first time for centuries, contributing something to the world's surplus of cereals; and from the South American states of the Argentine Republic and Chili, where extraordinary railroad construction is rapidly drawing an extraordinary European immigration to the finest of wheat-lands, which so recently as 1880 were practically inaccessible. Great, also, as is the present wheat product of the United States, Mr. Atkinson has shown that all the land at present in actual use in that whole country for growing maize or Indian corn, wheat, hay, oats, and cotton is only 272,000 square miles, out of 1,500,000 miles of arable land embraced in its present national domain; and, also, that the present entire wheat-crop of the United States could be grown on wheat-land of the best quality selected from that part of the area of the State of Texas by which that single State exceeds the present area of the German Empire.

In short, it would seem as if the world in general, for the first time in its history, had now good and sufficient reasons for feeling free from all apprehensions of a scarcity or dearness of bread. But while this is certainly a matter for congratulation, are there not, on the other hand, reasons for apprehension of serious disturbances to the material interests of that large part of the world's population engaged in agriculture, from the continued abundant production and decline in the price of their products?

The effect of the extensive fall in prices of agricultural products during the last decade has, as already pointed out, been most disastrous to the agricultural interests and population of Europe. It has reduced farming in England and Germany to the lowest stage of vitality, and has had less but similar effects in France, Italy, and Belgium. It has almost bankrupted the sugar-producing interests in the West Indies and the Dutch East Indies, and threatens the continuance of productive industries, and even of civilization, in these countries.* In 1880, 44

had almost doubled. Notwithstanding these remarkable results, the traffic which has been developed on the railways of India is less, in proportion to the population, than that of any country in the world. This is especially the case in reference to goods-traffic, which only represents some 0·05 of a ton per head of the population, as compared with three tons per head in Canada, and over seven tons per capita in the United Kingdom. But the goods-traffic of India is likely to develop very rapidly in the future, and especially in agricultural produce, of which only about 4,000,000 tons are now annually transported, as compared with 75,000,000 tons in the United States for less than a fourth of the population."—*Bradstreet's* (*N. Y.*) *Journal.*

* "In consequence of the low prices of sugar in Europe and America, owners of plantations and their lessees have speculated to such an extent that they have placed themselves on the brink of an abyss, and it is feared that this will totally stop the production of sugar in Java. This event would be in every way a great catastrophe. It would at once throw half a million of Javanese laborers out of employment, who would increase the already enormous number of Malay pirates."—*Journal des Fabricants de Sucre, October, 1886.*

per cent of the entire population of the United States was engaged in agriculture, and less than 7 per cent in manufactures; and since the year 1820, or for a period of sixty-six years, the proportion between the agricultural and non-agricultural exports of this country has been remarkably steady, the average for the former for the whole of this period having been about 78 per cent. Up to the present time there has been little tendency to change in these proportions; but, if the continued fall of prices of agricultural products in the United States and other countries should compel their farming populations to seek other employments, what other employments are open to them? That the world will ultimately adjust itself to all new conditions may not be doubted; but what of the period pending adjustment?*

* A recent writer in the (British) "Quarterly Review" broadly antagonizes the views above expressed respecting the prospective increasing production and continued low prices for wheat, and endeavors to prove that "it has been too hastily assumed that, in the struggle for existence among wheat-growers, the British, the best farmers in the world, will not be among the fittest who will survive." In support of this conclusion the writer starts with the proposition that the returns of the cost of growing wheat in Great Britain, collected in 1885, make the average about £8 ($40) per acre, and venturing the opinion that, with the general reduction of the rents of British farming-lands that have already taken place, and the practice of increased economies on the part of British farmers, they can grow wheat with a profit at 40*s.* and 45*s.* a quarter (although the average price of British wheat has not for some years reached that level), next assumes, that growers "in all parts of the world—with the doubtful exception of India—can not possibly keep up the present acreage of wheat at the recent or any lower range of prices." The writer further concludes, from an examination of American statistics, which he abundantly offers, that the area of wheat acreage in the United States is diminishing, and that the average farm-value of wheat in that country, for the years 1884–'86, was about 33*s.*, "which can not," he says, "yield a satisfactory profit under the most favorable circumstances."

The following reply to the conclusions of this writer in the "Quarterly," so far as they relate to the United States, which appeared in the columns of the "New York Commercial Bulletin" (May, 1887), strikingly illustrates how different the situation appears to a writer equally competent to discuss the question, when viewed from a trans-Atlantic standpoint:

"These guesses about the cost of wheat-producing in this country are highly interesting. Probably they will interest no one else so much as the American farmers, who know that they do not know, and have a strong impression that other people can not tel- them, the exact cost of raising wheat per acre. Very few of them produce any one crop under such circumstances that they can accurately compute, in dollars or days' labor, what that separate crop costs them; and fewer still know what they add to the value of their land by improvements, or take from it by exhaustion yearly. But one thing a great many of them do know, that they are going to raise more wheat next year than they did last, as they raised more last year than the year before; and they have been selling wheat for several years at about 45 cents per bushel, in great regions like Kansas, Minnesota, and Dakota, and yet the business is found so far profitable that the acreage in these very States enormously increases. It is supposed that Dakota, which produced 22,800,000 in 1880, and 22,000,000 bushels three years ago, will produce 30,000,000 in 1887."

(In 1880 the crop area of the State of Kansas was about 8,000,000 acres; for the present year (1887) the area planted is believed to be in excess of 16,000,000 acres.)

"The farmer in this country is, at the same time, a land-improver and a land-speculator, in most of the great wheat-growing States. He takes possession of a farm under the homestead law, by pre-emption, or by purchase from corporations, the land costing

Meats.—The price of meats, according to the statistics of English markets, exhibits no material decline, comparing the average prices of 1867–'77 and of 1878–'85. But during the years 1885 and 1886 the decline was very considerable, and extended also to most other animal products. The percentage of fall in the carcass prices of different kinds and quantities of meat in London, as given by the London "Economist" of November 27, 1885, was, in comparison with the prices for 1879, as follows: For inferior beef, 43 per cent; prime beef, 18 per cent; prime mutton, 13 per cent; large pork, 22 per cent; middling mutton, 27 per cent.

The immediate cause of this decline was undoubtedly the new sources of supply of live animals and fresh meats that have been opened up to Europe, and especially to Great Britain, from other than European countries: the value of the imports into Great Britain from North America of live animals having increased from $1,085,000 in 1876 to $22,980,000 in 1885; of fresh meat from $1,950,000 to $11,820,000; and of fresh meat from Australia and the River Plate (transported through refrigeration) from $890,000 in 1882 to $5,850,000 in 1885; a total increase of from $3,025,000 in 1870 to $40,650,000 in 1885. The ability of the three countries named to increase their exports of meat during such a brief period to such an enormous extent, constitutes of itself a demonstration of increased product and of the diminished price that is the invariable accompaniment of a surplus seeking a market. The decline in the average export price of salt beef in the United States was from 8·2 cents per pound in 1884 to 6 cents in 1886 (26 per cent); of salt pork from 8·2 cents to 5·9 cents

him so little that a single good crop or two pays for it outright. Then he puts into it labor of his own, and of men hired, which he could not otherwise utilize at all, and the cost of which he can not compute, and thus adds year after year to its value. The farmer who runs into debt can tell what his land costs him yearly, but they are not the majority. Most farmers get a living out of the land for themselves and families, to begin with, and make some improvements besides, and meanwhile are gaining more without any effort, than by all their labor. For, while the farmer is raising four or five crops, a settled State or county grows up about him. Towns and cities start from the ground. Railroads and manufacturing establishments come to enhance the value of his land. In a few years, the ground that he bought for $1.25 to $5 per acre comes to be worth in market price $10, $20, or $30 per acre. Land settled by men who are yet in their prime averages in value over $20 per acre for the entire State of Iowa, or $13 for the entire State of Minnesota, or $10 for the entire States of Kansas and Nebraska. That means for the owners of only a small farm a yearly saving which not many wage-earners are able to accomplish, and in all the more successful selections of land the increase in value and the consequent return for labor are far greater.

"Just as long as this occupation of new land and development of new territory are possible in this country, the most scientific calculation of the cost of growing wheat will have as much to do with its continued production or with its average price as it has to do with the height of mountains in the moon. Wheat-growing will continue, and the yield in this country will greatly exceed the demand, and an enormous surplus will be annually offered for sale, at prices with which British farmers can not easily compete, where the cost of growing wheat averages 'about $40 per acre.'"

(27 per cent); of bacon and hams from 9·6 cents to 7·5 cents; and of lard from 9·4 cents to 6·9 cents. In the case of lard-oil an exceptionally great decline in price in recent years—i. e., from an average of 94 cents per gallon (Cincinnati market) in 1881–'82 to a minimum of 48·8 cents in 1886, is claimed to be due mainly to the large production and more general use of vegetable oils—cotton-seed oil in the United States, and palm and cocoanut oils in Europe. The effect of the increased quantity and cheapness of these vegetable oils has been especially marked in England, France, Italy, and Germany; and has also undoubtedly influenced the price of tallow, the decline in which in English markets, comparing the average prices of 1867–'77 with those of 1886, having been 31 per cent, while in the United States the price for 1884–'85 was the lowest on record.

CHEESE.—American cheese experienced an extraordinary decline in price from 12 and 13 cents in 1880 to 8⅜ and 10⅛ cents in 1885; and as the American contribution of this article of food to the world's consumption has constituted in recent years a large factor, the world's prices generally corresponded with those of the American market. This decline in the United States was due mainly to increased product; the relative prices of butter and cheese during the years 1880–'81 being so much to the advantage of the latter, that large quantities of milk which had previously gone to the creameries to be made into butter, found their way into factories to be made into cheese; and for the years 1883, 1884, and 1885 the annual receipts at New York city averaged 25 per cent in excess of the receipts for 1880. Demand for export at the same time largely fell off, and so assisted in the decline of prices; the same influences existing in the United States having also apparently prevailed to a degree in other cheese-producing countries, the amount recognized by the trade as supplied to the great cheese-consuming countries, Great Britain, the Continent of Europe, and South America, having increased from 1880 to 1884 to the extent of 14 per cent.

FISH.—The year 1884 in the United States was notable for a plethora of all kinds of dry and pickled fish on the one hand, and of extreme low prices of such commodities on the other; mackerel having touched a lower price in the Boston market than for any year since 1849, while for codfish the price was less than at any time since the year 1838.

COFFEE AND TEA.—The decline in recent years in the prices of each of these great staple commodities has been almost as remarkable as has been the case with sugar, coffee having touched the lowest prices ever known in commerce in the early months of 1886, the price of "ordinary," or "exchange standard No. 5," having been 7½ cents per pound in January of that year in the New York market; while, according to Mr. Giffen, of the British Board of Trade, the decline in the price of tea, comparing 1882 with 1861, has been greater than that of sugar, or, indeed, of almost any other article. In both cases the decline would seem to find a sufficient explanation in a common expression of the trade circulars, "Our supplies have far outrun our consumptive requirements." In the case of coffee, the total imports into Europe and the United States, comparing the receipts of the year 1885 with 1873, showed an increase of 57 per cent; while the increase in the crops of Brazil, Ceylon, and Java during the same period has been estimated at 52 per cent. Subsequent to January, 1886, the price of coffee, owing to a partial failure of the Brazil crop, rapidly advanced more than 150 per cent, "ordinary" or "exchange" standards having sold in New York in June, 1886, at 22 cents per pound, the highest point in the history of American trade, unless possibly during the war, when entirely abnormal circumstances controlled prices. From these high prices there was a subsequent disastrous reaction and extensive failures. In the matter of the supply of tea, the total exports from China and India increased from 234,000,000 pounds in 1873 to 337,000,000 pounds in 1885, or 44 per cent; the exports from India having increased from 35,000,000 pounds in 1879 to 68,000,000 pounds in 1885.*

Hops.—The report of the German Hop-Growers' Association for 1886 estimates the quantity grown throughout the world in that year at 93,340 tons, and the annual consumption at only 83,200 tons, so that there was an excess of production over consumption in 1886 of nearly 10,000 tons. As might have been expected, there was a notable decline in the world's prices for hops.

Such having been the production and price experience in recent years of the world's great food commodities, attention is next invited to a similar record of experience in respect to the metals.

Iron.—Sir Lowthian Bell, recognized as one of the best authorities on the production of iron and steel, in his testimony before the Royal British Commission in 1885, fixed the world's production of pig-iron in 1870 at 11,565,000 tons, which increased to 14,345,000 tons in 1872. From that date production continued almost stationary until 1879,

* The British Chancellor of the Exchequer, Mr. Goschen, in his budget speech for 1887, calls attention to the following curious incident of financial disturbance growing out of a change in the quality of a staple commodity—tea—which, in turn, has been contingent on a change in the locality or country of its production: "Whereas, ten years ago," he said, "we (Great Britain) received 156,000,000 pounds of tea from China and 28,000,000 pounds from India, or 184,000,000 pounds altogether, in 1886 we received 145,000,000 pounds from China and 81,000,000 pounds from India. In the transfer of consumption of tea from the tea of China to that of India, we have to put up with a loss of revenue owing to the curious fact that the teas of India are stronger than the teas of China, and therefore go further, so that a smaller quantity of tea is required to make the same number of cups of tea." Mr. Goschen further called attention to the fact that "the fall in the price of tea and sugar (in Great Britain) has been so great, that whereas in 1866 a pound of tea and a pound of sugar would have cost 2*s.* 6*d.* and in 1876 2*s.* 1¼*d.*, in 1886 they would have cost only 1*s.* 7¼*d.*, or 3*d.* less than they would have cost in 1866 with all the duties taken off."

when it was 14,048,000 tons. "After 1879 an extraordinary change became apparent in the volume of the make, for during the ensuing five years the average make was 18,000,000 tons, and in 1883 it rose to 21,063,000, or nearly 50 per cent more than it was in 1879." The witness further estimated that while the product of iron increased in the United Kingdom at the rate of 131 per cent from 1870 to 1884, the increase in the production of the rest of the world during the same period had been 237 per cent.

The tables of the American Iron and Steel Association, prepared by Mr. James M. Swank, indicate an increase in the pig-iron product of the world, from 1870 to 1886 inclusive, of about 100 per cent. All authorities are therefore substantially agreed that the increase in the production of this commodity in recent years has been not only far in excess of the increase of the world's population in general, but also of the increase of the population of the principal iron-producing countries. Thus, for example, in the United States, the production increased from 4,044,526 gross tons in 1885 to 5,683,329 in 1886, an increase of 1,638,803 tons, or 40 per cent.

Under such circumstances, the price of pig-iron throughout the world has rapidly declined, and in the case of some varieties touched in 1885–'86 the lowest points in the history of the trade. American pig, which sold in February, 1880, for \$45 per ton, declined almost continuously until September, 1885, when the low point of \$16⅝ was reached; while in Great Britain, Cleveland pig, which sold for £4 17*s*. 1*d*. in 1872, and £2 5*s*. in 1880, declined to £1 10*s*. 9*d*. in 1886. The decline in Bessemer steel rails in the English market was from £12 1*s*. 1*d*. in 1874 to less than £4 in 1887. In the United States, Bessemer steel rails, which commanded \$58 per ton at the mills in 1880, fell to \$28.25 at the close of the year 1884, reacting to \$39½ in March, 1887.

Reviewing, specifically, the causes which have contributed to the above-noted extraordinary decline in the prices of iron, the following points are worthy of notice:

*First.* The testimony of Sir Lowthian Bell shows that foreign countries have within recent years, and contrary to former experience, increased their production of iron in a far greater ratio than Great Britain, which was formerly the chief factor in the world's supply; and, in consequence, have become formidable competitors with Great Britain, not only in their own territories, but also in neutral markets. New fields of iron-ore have been discovered in Germany, France, and Belgium, very analogous in point of character to those which by discovery and development, about the year 1850, in the north of England, led to the subsequent great and rapid increase of British iron production.

*Second.* The power of producing iron with a given amount of labor and capital has, in recent years, greatly increased. For example, the average product per man of the furnaces of Great Britain, which for 1870 was estimated at 173 tons, is reported to have been 194 tons in 1880, and 261 tons in 1884.

*Third.* The substitution of steel for iron has resulted in a notable diminution of the consumption of iron for the attainment of a given result, or, in other words, more work is attainable from a less weight of material. Sir Lowthian Bell, in his testimony before the Royal British Commission, stated that a ship of 1,700 tons requires 17 per cent less in weight of pig-iron, in being built of steel rather than of iron, and is capable of doing 7 per cent more work.

Again, the quantity of pig-iron requisite for keeping a railroad in repair will depend greatly upon the state in which iron enters into construction; rails of steel, for example, having a far greater durability than rails of iron.*

A further example of recent economic disturbance consequent upon changes in the manufacture of iron—characterized by the Secretary of the British Iron Trade Association, in his report for 1886, as "one of the most remarkable of modern times"—is to be found in the rapid disuse of the system invented about one hundred years ago by Henry Cort for converting pig-iron into malleable iron by the so-called process of "puddling." Twenty years ago the use of this process was almost universal, to-day it is almost a thing that has past; and the loss of British capital invested in puddling-furnaces which have been abandoned in the ten years from 1875 to 1885, is estimated to have approximated £4,667,000, or $23,333,000, involving in Great Britain alone a displacement, or transfer of workmen to other branches of industry during the same period of about 39,000.

Copper.—This metal touched the lowest price on record in 1886, Lake Superior copper in New York falling from 25 cents per pound

* Opinions, as yet, vary greatly as to the comparative durability of iron and steel rails. In the testimony given before the British Royal Commission, Mr. I. T. Smith, manager of the Barrow Steel Company, gave it as his opinion that the life of a steel rail is three times that of an iron rail, adding, "My reason for saying so is, that I know that upon the London and Northwestern Railroad, where steel rails have been now in use more than twenty years, they consider it so."

Sir Lowthian Bell also, in testifying before the commission, on the effect on the iron-trade of Great Britain from the expected longer duration of steel rails, says: "Assuming iron rails to last twelve, and steel rails twenty-four years, instead of the railways now in existence in the United Kingdom requiring 465,648 tons annually for repairs, 232,824 tons will suffice for the purpose. Although this only involves the saving of a comparatively small weight of pig-iron, it means less work for remelting and for our rolling-mills, say to the extent of 4,000 to 5,000 tons per week." The difference in duration of iron and steel rails is not, however, in itself a complete measure of the amount of pig-iron required for renewals. This arises from the fact that an iron rail splits up and becomes useless long before the actual wear, as measured by the diminution of weight, renders it unsafe, which often happens when the loss of weight does not exceed 4 per cent of the original weight. Steel rails, on the other hand, go on losing weight until they are from 10 to 20 per cent lighter than when they were laid down, before becoming unsafe.

in 1880 to 9½ cents in August, 1886; and in the case of no other single commodity is the connection between the decline in price and the increase of production so well established and so significant. The increase in the copper product of the world is estimated by Mr. Sauerbeck to have been 97 per cent in the thirteen years from 1873 to 1885, inclusive; while according to the report of the United States Geological Survey, 1886, the increase from 1879 to 1885 was nearly 47 per cent (46·8). The countries which have most notably contributed to this increased product have been the United States, Spain, and Portugal; the increase in the case of the former having been from 23,000 tons in 1879 to 74,053 tons in 1885; and in that of the latter, from 32,677 tons to 45,749 in the same period. As in all other like cases, the disturbing effect on the industries involved—mining and smelting—contingent on this rapid and remarkable fall of prices, was very great, and in all quarters of the world. In Montana, the Montana Copper Company, with an annual product of 8,000,000 pounds of pure copper, entirely suspended operations; and the Anaconda Company, with an annual product of 36,000,000 pounds, shut down 20 out of 28 furnaces, and discharged most of its hands at the mine. In Chili, production during the year 1885 was diminished to the extent of about 10 per cent. In Germany the great Mansfield mine, which reported gross profits in 1884 of 5,675,000 marks, sustained a loss in the operation of 1885 of 653,338 marks; and its managers have since sought relief by petitioning the Imperial Government for the imposition of a higher tariff on the imports of copper into the empire. For the years 1881–'83 the great San Domingo mine in Portugal paid annual dividends of 12½ per cent; in 1885 the annual rate was reduced to 3¾ per cent. It is important also to note, as throwing light upon the problem of the recent reduction of prices, that while in the case of copper the increase of product has been confessedly immense, three other agencies—one permanent, and the other two of a temporary character—have contributed to its recent decline in price. The *first* is, that there has been a reduction in the cost of mining, smelting, and marketing copper at the principal mines of the world, owing to improved processes, and reduced rates of transportation contingent on railroad construction. In the case of the Lake Superior mines, this reduction is very striking; in the "Quincy" mine, for example, the cost of production in cents per pound having been reduced from 10·03 in 1881, to 7·50 in 1885; and in the "Atlantic" from 13·80 to 9·37 in the corresponding period. *Second.* The recent discovery and rapid development of new and rich mines in Montana, Arizona, the Dominion of Canada, and elsewhere, have left a feeling of apprehension in the world's market as to the conditions of the supply of this metal in the future. *Third.* The consumption of copper in Europe, for the year 1886, fell off 14,000 tons below the average for the two preceding years—a result attributed mainly to the dullness of ship-building, and the various metal industries.

Lead experienced a decline, comparing the highest market prices in New York, in January, 1880 and 1885, respectively, of about 39 per cent; or, comparing the average of prices for New York and London for the same years, about 30 per cent. The world's production of lead between the years 1880 and 1883 appears to have increased in nearly the same ratio, or far in excess of the increase of the world's population within the same period. With an approaching exhaustion of a number of the heaviest lead-producing mines in the Rocky Mountains, United States,* and a notable decline in the lead product of British ores (50,328 tons in 1882 as compared with 37,687 tons in 1885), the price of lead tends to increase. The decline in the price of lead, above noted, occasioned the suspension or bankruptcy of many English lead-mining companies, and during the year 1885 much distress from this cause was reported as existing among English lead-miners. The following is an example of another economic disturbance contingent on changes in the production and price of lead: Formerly the domestic supply in the United States of white-lead and of all paints, the basis of which is oxide of lead, was derived almost exclusively from manufactories situated upon the Atlantic seaboard; but with the discovery and working of the so-called silver-lead mines of the States and Territories west of the Mississippi, and the production of large quantities of lead as a product residual, or secondary to silver, the inducements offered for the manufacture of white-lead and lead-paints, through local reductions in the price of the raw material and the saving of freights, have been almost sufficient to destroy the former extensive white-lead and paint business in the eastern sections of the United States, and transfer it to the western.

Nickel, not many years ago, was a scarce metal of limited uses, and commanded comparatively high prices. Latterly the discovery of new and cheaper sources of supply has tended to throw upon the market an amount in excess of the world's present average yearly consumption—estimated at between 800 and 900 tons—and, as a consequence, there has been "over-production, and unsatisfactory prices to dealers." There is, moreover, little prospect that prices in respect to this metal will ever revive—one mine in New Caledonia alone being estimated as capable of producing two or three thousand tons annually, if required; while the discovery of richer and more abundant ore deposits than have ever before been known is reported as having resulted from the construction of the Canadian Pacific Railroad.

Tin.—The production and price experiences of this metal during the last quarter of a century have been very curious. The world's consumption of tin from 1860–'64 constantly tended to be in excess of production, and prices rose from £87 (the lowest figure) in 1864 to £159 (the highest) in 1872. In this latter year the mines of Australia began to produce very largely, and in a short time afforded a

* Report of the United States Geological Survey, 1886.

supply equal to one third of the world's current consumption. Under such circumstances the price of tin rapidly declined, and in October, 1878, touched £52 10*s.*, the lowest price ever known in history; a decline of 66 per cent. For some years past, however, the product of tin in Australia has been declining, that of the "Straits" increasing, and that of England and other countries remaining nearly stationary. But the consumption of tin throughout the world has gone on continually increasing, until now the surplus stock is being so rapidly reduced, that unless new sources of supply are developed, famine rates may again occur; prices having advanced continuously from £52 10*s.* in 1879 to £107 in June, 1887.

TIN PLATES.—Owing to a well-recognized tendency of consumption to exceed production, tin plates in common with tin ruled at what were termed "famine" prices in 1872, and for some years previous; the average price for "coke" plates being from 26*s.* to 27*s.* per ton. Since 1872 the decline has been in excess of 50 per cent—the quotations for the first half of the year 1887 having been from 12*s.* 6*d.* to 13*s.* per box. This remarkable and steady decline in the prices of this commodity during the last fifteen years, is as clearly and certainly understood as in the case of tin, above noticed; and is referable to three causes: *First,* the reduction in the cost of the metal tin. *Second,* to the revolution in the manufacture of iron, and the extensive substitution of steel (plates) in place of charcoal and puddled iron plates. *Third,* to new processes of manufacture and tinning; a modern tin-plate mill turning out every twenty-four hours more than double the product of old-fashioned mills, without any increase in expenditure for motive power or labor. Supply and consumption alike under such circumstances have increased to an enormous extent, and the tin-plate trade, instead of being a minor industry of the world, as was formerly and not remotely the case, has become one of great magnitude. The decline in prices has, however, brought nothing of prosperity to the British tin-plate manufacturing industry; as out of an average of eighty-two works in existence during recent years in South Wales, there have been no less than forty failures.*

QUICKSILVER.—Excepting petroleum and quinine, the decline in price of this metal seems to have been greater in recent years than

* An attempt on the part of Germany to break in upon the almost complete monopoly of the manufacture of tin plates enjoyed by Great Britain, by imposing a heavy duty on their importation, has been singularly unsuccessful; domestic (German) production and exports having diminished, and exports increased, as will appear from the following table:

| YEAR. | Production, tons. | Imports, tons. | Exports, tons. |
|---|---|---|---|
| 1885 | 4,892 | 5,798 | 186 |
| 1878 | 8,582 | 5,307 | 1,696 |

that of any other leading commodity—i. e., from £26 per flask (the highest) on the London market, in 1874, to £5 2*s.* 6*d.* (lowest) in 1884; and from $118 (highest) to $26 (lowest) on the San Francisco market during the same period—a decline of 77·1 per cent. The explanation of this movement of price is to be found mainly in the circumstance that California, which furnishes nearly one half of the world's supply of this metal, increased her production from 30,077 flasks in 1870 to 79,684 in 1877; and although, as the result of low prices, only ten of thirty working mines of California were in operation in 1885 (none of which paid a dividend in that year), the generally increased supply of quicksilver, coupled with its diminished use in the reduction of silver-ores—consequent on the introduction and use of cheaper processes—has thus far prevented any material augmentation in its price, the London quotation for June, 1887, having been £6 15*s.* per flask.

Silver.—The annual supply of silver from the mines of the world has largely increased since 1872–'73, the period covered by the marked decline in the market price of silver, or from $65,000,000 in 1872 to $102,168,000 in 1881; $115,000,000 in 1883, and $124,000,000 in 1885—an increase in supply in fourteen years of 90·7 per cent.*

Coal.—The decline in the export prices of British coal, comparing the average for 1867–'77 with 1886, was about 33 per cent. The decline in the average annual price of anthracite coal (by the cargo at Philadelphia), comparing 1870 with 1880, was 38 per cent; but, as between 1870 and 1886, it was only 6·6 per cent. The total production of all kinds of coal in the United States in 1886, according to the returns of the United States Geological Survey, shows a net gain of 1,785,000 short tons, as compared with 1885, but a loss in value at the point of production of $4,419,420.

The increase in the product of the five chief coal-producing countries of the world, Great Britain, the United States, Germany, France, and Belgium, from 1870 to 1886 inclusive, has been in excess of 80 per cent—Great Britain increasing her product from 109,000,000 tons in 1870 to 159,351,000 in 1885; and the United States from 38,468,000 in 1870 to 112,743,000 short tons in 1886. On the other hand, the amount of coal displaced from use in the United States in 1886 by the introduction and use of natural gas is estimated by the United States Geological Survey at 6,353,000 tons, valued at $9,847,000. In Germany, the increase reported was from 36,041,000 tons in 1873 to 55,000,000 tons in 1883. In 1870 the average output of coal per miner in the British coal-mines—counting in all the men employed—was 250 tons, an amount never before reached. In 1879 this average had increased to 280 tons per man, and in 1884 the average for the five preceding years was reported at 322 tons, an increase of 42 gross tons of 21 cwt.

* The estimates of the annual silver production of the world, submitted to the Royal (British) Commission on Gold and Silver by Mr. Hector Hay, are somewhat smaller, namely, £12.8 in 1873; £18.8 in 1881; £20.6 in 1883; and £21.3 in 1885.

per man per annum. For Germany, the increase was from 261 tons in 1881 to 269 tons in 1883; and in Belgium, for corresponding years, from 165 tons to 178 tons per miner.

Recent inventions have also done much to reduce the amount of coal formerly used to effect industrial results, particularly in the case of blast-furnaces and coke-ovens. For example, at blast-furnaces, coal was formerly used for heating the boilers that furnished steam for blowing, hoisting, etc., and for heating the air which was blown into the stacks. Now, a well-ordered set of blast-furnaces does not use a single ounce of coal except what goes in to melt the ore. The whole of the heat used to produce the steam required in connection with the furnace, and for heating the stoves for making the hot blast, is obtained from the gases which rise to the top of the stacks in the process of smelting the iron, and which formerly was all thrown away.*

Petroleum.—Crude petroleum declined in the American market from an average of $3.86 (gold) per barrel in 1870 to 87½ cents per barrel in 1885, and 71½ cents in 1886, a total decline of over 80 per cent.

The American annual production (including Canada) increased during the same period from 5,510,745 barrels in 1870 to 30,626,100 in 1882, declining to 25,798,000 in 1886.

That the production and price experiences of the great staple fibers of commerce and consumption in recent years have not been dissimilar to those of the foods and metals, will also appear from the following:

Cotton.—Comparing 1860 with 1885, the decline in the price of American cotton (middling uplands) in the New York market has not been material. The year 1886, however, witnessed a decline to a lower point ($8\frac{13}{16}$) than has been reached, with one exception, since the year 1855; the exception occurring just after the failure of the Glasgow Bank in Scotland in 1878, the lowest quotations in both years being exactly the same. On the other hand, the increase in the world's supply of cotton in recent years has been very considerable, the American crop increasing from 3,930,000 bales in 1872–'73 to 6,575,000 in 1885–'86, or 67 per cent; while the supply of the world for the corresponding period is estimated to have increased from 6,524,000 bales to 8,678,000 bales, or at the rate of about 32 per cent. Such an increase in production would undoubtedly have occasioned a more marked decline in price, had it not been for a great and coincident increase in the world's consumption of cotton fabrics; which, in turn, was undoubtedly in consequence of a material decline in the cost of the same, as the result of improvements in machinery and methods of production; the equivalent of the labor of an operative in the factories of New England having increased from 12,164 yards in 1850 to 19,293 in 1870, and 28,032 in 1884, while the reduction in the price of

* Testimony of J. D. Ellis, chairman of John Brown & Co., Sheffield, British Commission, 1886.

standard sheetings from 1850 to 1885 has been about 10 per cent, and of standard prints and printing-cloths, during the same period, approximately 40 per cent.

Wool.—According to the statistics of Mr. Sauerbeck ("Journal of Statistical Society," March, 1887), the price of merino wool (Port Philip, Australia, average fleece), comparing the average of the series of years 1867–'77 and 1878–'85, declined 10·7 per cent; or, comparing the average price of 1867–'77 with that of the single year 1886, when wool "was cheaper than at any time within the memory of the present generation," 27 per cent. Certain fibers classed with wool, and known as "alpaca" and "mohair," and the grade of long-combing English wools known as "Lincoln," experienced a much greater decline after 1874–'75, owing to the curious circumstance that a change in fashion in those years almost entirely and suddenly destroyed any demand for the before popular, stiff, lustrous fabrics manufactured from such wools for female wear, and substituted in their place the soft and pliable cloths that are made from the merino wools.

The increase in the production and world's supply of raw wools, from the years 1860 to 1885 inclusive, was about 100 per cent. According to Mr. Sauerbeck's tables, the increase from 1873 to 1885 inclusive, was 20 per cent; according to Messrs. Helmuth, Schwartze & Co., of London, the increase from 1871–'75 to 1881–'85 was 23 per cent; and from 1871–'75 to 1886, 35 per cent. The wool-clip of the United States increased from 264,000,000 pounds in 1880 to 329,000,000 in 1885, or 24·6 per cent in six years. Such an increase in the world's supply of wool would undoubtedly have resulted in a greater decline in prices, had not the increase been accompanied, as was the case with cotton, with a very marked increase during the last quarter of a century in the world's consumption—i. e., from 2·03 pounds of clean wool per head in 1860 to 2·66 pounds in 1886.*

Silk.—The decline in the price of silk (Tsatlee), according to Mr. Sauerbeck, from the average price of 1867–'77 to the average of 1886, was about 40 per cent; and the average increase in supply of all varieties of silk-fiber, comparing 1873 with 1885, was reported by the same authority as about 12 per cent. No relation between the price movements of this commodity and supply and demand or any other agencies can, however, be established, which fails to take into account the great increase in the use of the ramie and other fibers and materials within recent years as substitutes for or adulterations of silk in the

* The details of this increase are thus stated by Messrs. Helmuth, Schwartze & Co., of London, in their annual review of the production and consumption of wool for 1887: "Making allowance," they say, "for the increase of population, we find that the principal development in the supply of wool took place from 1860 to 1868, in which period the consumption rose from 2·03 pounds of clean wool per head to 2·47 pounds, or about 22 per cent. From 1868 to 1879 the consumption remained practically unchanged, amounting on the average to 2·41 pounds clean wool per head. It rose to 2·49 pounds for the average of the next four years, and was 2·58 in 1884 and 2·66 pounds in 1886."

manufacture of fabrics, and which must obviously have an effect on the price of raw silk equivalent to an increase in its supply.

JUTE.—Good medium jute declined on the London market from £17 per ton in 1874 to an average of £11 10*s*. in 1886, or more than 32 per cent. The increase in exports from British India was from 5,206,570 cwt. in 1876 to 10,348,909 cwt. in 1883, or 98 per cent.

NITRATE OF SODA.—The recent price experiences of nitrate of soda (Chilian saltpeter) have been very curious. The supply of this article, which corresponds to the more valuable nitrate of potash (true saltpeter), is practically limited to one locality on the earth's surface —a rainless, desert tract—in the province of Tarapacá, which formerly belonged to Peru, but has recently been annexed to Chili. It is cheaply and plentifully obtained, at points from fifty to ninety miles from the coast, by dissolving out the nitrate salt from the desert earth, which it impregnates, with water, and concentrating the solution by boiling to the point where the nitrate separates by crystallization. Up to the year 1845 it was an article so little known to commerce, that only 6,000 tons were annually exported; but as its value as a fertilizing agent in agriculture, and as a cheap source of nitrogen in the manufacture of nitric acid, became recognized, the demand for it rapidly increased until the amount exported in 1883 was estimated at 570,000 tons, or more than a thousand million pounds. To meet this demand and obtain the profit resulting from substituting skillful for primitive methods of extracting and marketing the nitrate, foreign capital, mainly English, extensively engaged in the business. A large amount of English-made machinery, and many English engineers and mechanics, were sent out and planted in the desert; additional supplies of water were secured, and a railroad fifty-nine miles in length constructed to the port of Iquique on the sea-coast, for the transportation of coal, provisions, and other material *up*, and the nitrate as a return freight *down*. So energetically, moreover, was the work pressed, that at the last and most complete establishment constructed under English auspices, the business, employing when in full operation six hundred men, was prosecuted unremittingly by night (by the agency of the electric light) as well as by day. The result was exactly what might have been anticipated. The export of nitrate, which was 319,000 tons in 1881, rose to 570,000 tons in 1883; and prices at the close of 1883 declined with great rapidity to the extent of more than 50 per cent, or to a point claimed to be below the cost of production. Such a result, threatening the whole business with disaster, led to an agreement on the part of all the interests concerned, to limit from June, 1884, to January, 1887, the product of every establishment to 25 per cent of its capacity. But notwithstanding these well-devised measures, prices have not been restored to their former figures, the average price per cwt. in London having been 10*s*. in 1886, as compared with an average of 14*s*. for 1867–'77.

For May, 1887, the quotations had advanced to 11*s.* and 11*s.* 5*d.* This case is especially worthy of notice, because it constitutes another example of a great and rapid decline in the price of a standard and valuable commodity in the world's commerce, and for which—all the facts being clearly understood—it is not possible to assign any other cause than that of production in excess of any current demand for consumption, and which in turn has been solely contingent on the employment, under novel conditions, of improved methods for overcoming territorial and climatic difficulties.

Concurrently with the fall in the price of nitrate of soda, saltpeter, or nitrate of potash, also notably declined from 28*s.* 3*d.* in 1880 to 21*s.* in 1887 (for English refined), a fact which seems to find a sufficient explanation in the circumstance that nitrate of soda can be used to a certain extent as a substitute for nitrate of potash, and that the export of the latter from India, the country of chief supply, increased from 352,995 cwt. in 1881 to 451,917 cwt. in 1885, or 36 per cent.

Paper.—A quarter of a century ago, or less, paper was made almost exclusively from the fibers of cotton and linen rags; and with an enormous and continually increasing demand, paper and rags not only rapidly increased in price, but continually tended to increase, and thus greatly stimulated effort for the discovery and utilization of new fibrous materials for the manufacture of paper. These efforts have been so eminently successful that immense quantities of pulp suitable for the manufacture of paper are now made from the fibers of wood, straw, and various grasses, and so cheaply that the prices of fair qualities of book-paper have declined since the year 1872 to the extent of fully 50 per cent, while in the case of ordinary "news" the decline has been even greater. Rags, although still extensively used, have, by the competitive supply of substitute materials, and a consequent comparative lack of demand, been also greatly cheapened.

Quinine.—But in no one article has the decline in recent years been more extraordinary and thoroughly capable of explanation than in the case of sulphate of quinine, a standard chemical preparation used extensively all over the world for medicinal purposes. In 1865 the highest price of sulphate of quinine in the English market was 4*s.* 4*d.* ($1.07) per ounce, which gradually advanced to 9*s.* 6*d.* in 1873, reacting to 6*s.* 9*d.* in 1876. In the subsequent year, owing to an interruption in the exportation of cinchona-bark from South America by civil war in New Granada, and by low water in the Magdalena River, the price advanced to the unprecedently high figure of 16*s.* 6*d.* ($4.70) per ounce, receding to 13*s.* in 1879, and 12*s.* in 1880. In 1883 identically the same article sold in Europe for 3*s.* 6*d.* per ounce, and in 1885 for 2*s.* 6*d.*, a result entirely attributable to the successful and extensive introduction and growth of the cinchona-tree in the British and Dutch East Indies, and to the further very curious circumstance that, while the cinchona-barks from South America—the product of indigenous trees—yield on an average not over 2 per cent of quinine, the bark of the cultivated tree in Java is reported to yield from 8 to 12 per cent.

The decline in the prices of many chemicals, due to improvements in methods and to excess of production, has also been very great—the decline in soda-ash from 1872 having been 54 per cent, while bleaching-powders (chloride of lime) declined from £10 in 1873 to £6.15 in 1878, reacting to £9 in 1887.

Many other commodities, of greater or less importance, might be included in this investigation, with a deduction of like results; but a further exhibit is not necessary. For it is difficult to see how any one can rise from an examination of the record of the production and price experiences of the commodities which have been specified, which, it must be remembered, represent—considered either from the standpoint of qualities or values—the great bulk of the trade, commerce, and consumption of the world, without being abundantly and conclusively satisfied that the decline in their prices, which has occurred during the last ten or fifteen years, or from 1873, has been so largely due to conditions affecting their supply and demand, that if any or all other causes whatever have contributed to such a result, the influence exerted has not been appreciable; and further, that if the prices of all other commodities, not included in the above record, had confessedly been influenced by a scarcity of gold, the claims preferred by the advocates of the latter theory could not be fairly entitled to any more favorable verdict than that of "not proven."

But have all other commodities, for which conclusive evidence of a recent greatly-augmented production can not be adduced, exhibited in their recent price movements any evidence of having been subjected to any influences attributable to the scarcity of gold? For the consideration of this question, reference is made to the next paper of this series.

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Professor N. S. Shaler advocates, in the "Popular Science News," a system of international co-operation in meteorological observation. We need it in order to obtain a wider field whence to draw data for forecasts, so that we may make them for longer periods; for the proper study of the "meteorological unit," which the whole North Atlantic basin constitutes; for the proper determination of the work and influence of the Gulf Stream and of the Pacific Current; for the investigation of variations of the sun's heat, the field of observation for which should cover nearly the whole earth; and for the study of extra-meteorological phenomena like earthquakes and earth-tremors. We can hardly determine what is of importance to the climates of Europe and America without a pretty thorough study of all the great climatal units of the earth. The seven nations, Great Britain, the United States, France, Germany, Russia, Spain, and Holland, with their colonies, are so situated that, with their co-operative action, no great area of the earth, except the polar regions and the central oceanic areas, need be without regular frequent observations in aid of these studies.

# COLOR-BLINDNESS AMONG RAILROAD EMPLOYÉS.*

By WILLIAM THOMSON, M. D.,
PROFESSOR OF OPHTHALMOLOGY IN THE JEFFERSON MEDICAL COLLEGE OF PHILADELPHIA.

THE conflict between the officers and the employés of the Reading Railroad, with its forty-two thousand employés on three thousand miles of track, which has occupied recently the attention of the public, and has threatened to produce a suspension of work on that road, has reopened the question of color-blindness among railroad employés, and led to a full demonstration of its existence among those engaged even as engine-men, where the defect might lead to serious accidents, with loss of property and life. The officers of the road have selected the system for examination suggested by the writer, and employed to a full success for more than five years past on the Pennsylvania Railroad, and have appointed me to supervise its details, and, as ophthalmological expert, to decide all doubtful cases after careful examination of those found defective by the non-professional examiners of the company.

The conflict is nearly over, since demonstrations of the optical defect in engineers, made before a committee appointed by the employés have satisfied them of the propriety of the testing, and that the safety of the traveling public demands the removal of all color-blind persons from positions where their optical defect might be the cause of distressing accidents. In the recent demonstrations, I was able at my office to show that an engine-man declared a red danger-signal, made by placing red glass in front of a large gas-light at a distance of two feet away, to be a green light; he was also not only unable to distinguish a red from a green flag within six feet, but he failed to classify the flags, white, red, green, and blue, properly, even when allowed to take them in his own hands.

The system adopted by the Reading Railroad is the one in use on the Pennsylvania Railroad, and owes its value to the fact that large bodies of employés can be brought under inspection, and their defects discovered by non-professional examiners. It has been fully described in the "Medical News" of January 14, 1882, in the second edition of Nettleship's work on "Diseases of the Eye," and in a paper read before the American Association for the Advancement of Science, in September, 1884, and in "The Popular Science Monthly" for February, 1885, and to those sources the reader is referred for further information.

Previous to its adoption by the officers and directors of the Pennsylvania Railroad two thousand men were examined, and their blanks

* An article on this subject, by Dr. Thomson, was published in the "Monthly" for February, 1885, and, as a continuation of that paper, we give herewith from the "Medical News" an account of the more recent experience of the Pennsylvania Railroad with the system of examinations mentioned, and the results of its application to other lines.—Ed.

submitted to me, and the color-blind men sent to my office for final action. Mr. Pugh, General Manager, stated, in September, 1884, that there were thus detected four per cent of men color-blind, and ten per cent of men deficient in acuteness of vision, and that, although it was very difficult to keep accurate notes of all examinations, he was satisfied that all dangerous persons had been removed up to that date, when over twelve thousand employés had been submitted to the system.

The statistics obtained upon the two thousand men were used as the standard by all the Division Superintendents, and, however difficult it might be to report to the central office the full details of their examinations, they were always controlled by these known and accepted ratios. It has not been found requisite to send all men deficient to the ophthalmological expert, since they did not demand it, but submitted to the changes rendered necessary without opposition ; hence, I am unable to furnish exact reports of the examinations made at remote portions of the road. Most of the color-blind men have passed under my hands, as well as many cases of astigmatism, optical defects, and diseases or injuries reducing the sight below the standard, and the results may some time be found worthy of publication.

An opportunity to present the last opinions of the officers of the Pennsylvania Railroad has been afforded by a request which was made by the German Government, through its Minister, to the Surgeon-General of the United States Army, for statistical and other information on the subject, and this letter, referred to me by the Surgeon-General, has been answered by Mr. Pugh, who has kindly made efforts to obtain the figures from the great organization of which he is General Manager. He writes, under date of July 7, 1887, and says :

"I regret that so long a time has elapsed since the receipt of yours of May 25th, and this reply. The delay has been occasioned by our efforts to obtain some statistical information, which I regret to find has not been kept up as closely as was intended. I inclose herewith statements showing the number of employés examined during the past five years, with the results stated.

"I can only add that we have attained the most satisfactory results from the system, and I think we can confidently claim that sense of security which follows the belief that we have no one employed in any position in which the use of signals is required, whose color-sense and sense of vision will not enable him to accurately determine all signals by which his action is governed."

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| Total number examined on lines east of Erie | 25,158 |
| Color-blind | 481 |
| Defective vision | 661 |
| Hearing | 158 |

I am informed that the system has been found so satisfactory that it has been extended to the lines west of Pittsburg, and no doubt is now in use throughout all the lines controlled by the Pennsylvania

Railroad, including seven thousand miles of track and one hundred thousand employés.

It will be remembered that this system is also used to prevent the admission of defective men into the service, and that the apparently small percentage of color-blind in this table may be ascribed to the non-application of men who know their deficiency, and to the fact that men in the service knowing their defect would leave the road before examination, and thus escape detection, and be enabled to gain employment on other roads where no examinations are required. Perhaps twelve or thirteen thousand was the number who were subject to examination by virtue of being in positions where color-signals were used to direct them, in 1884, and the difference between that number and the total twenty-five thousand would be made up of new men who would present a small ratio of those below the standard, since men conscious of color-blindness, or poor sight, would not apply.

The fact that the intelligent officers of the Pennsylvania Railroad have adopted this system, purged their old force of all dangerous men, extended its use to all parts of their immense railroad, and now oppose it as a barrier to the admission of men thus unfit for service, is the best evidence that can be adduced to claim for it a successful place among the efforts to render scientific truths of practical value to the world. It is hoped that the Reading Railroad will be sustained in its contest with its employés by the example so quietly conducted by the Pennsylvania Railroad, and that the reform so necessary for the traveling public and for those employés who carry their lives in their hands daily, may be conducted to a happy finish.

## THE SAVAGERY OF BOYHOOD.

By JOHN JOHNSON, Jr.

THE following train of reflection was suggested to me by reading, among a number of compositions by my pupils, this blood-curdling narrative :

"Not long ago, when one of the boys went up to bed, he was standing close to the window, undressing himself, and a little bird came fluttering around the window on the outside. At first we thought it was a bat, but after a while we came to the conclusion that it was a little bird. Then we opened the window and let it in. It seemed to be crippled or very cold, and it could not fly very well, although it would keep out of our reach. We tried to catch it by running after it, but we soon got tired of that, and we began to throw our hats at it. Sometimes we would strike it with a hat, but that didn't do much good, until the bird was tired of flying, and it got under a bed, and we caught it. Then we went up the hall, and wrung its head off.

After we had wrung its head off, we got the wings, and threw the rest of the bird out of the window. J. F. T."

My twelve-year-old Procrustes has brought out his deed in all its stark brutality, and evidently he is not ashamed of it. His language, so entirely devoid of all compunction, is sufficient evidence on this point; but I can strengthen the testimony by my experience that a boy never puts into his composition any idea the propriety of which he questions in the least. As every one knows who has many dealings with children, they are remarkably shy about letting their feelings be known to grown people, and they will scarcely ever deliberately express a thought before their elders which they think may be disapproved of. Consequently, I feel very sure that the young savage just quoted saw nothing evil in his act, and that his unawakened conscience gave him no pang as he recalled the heartless butchery of the bewildered guest against whom he had violated the laws of hospitality. On the contrary, there is a tone about his words as of savage complacency—the complacency of the Dyak who recounts his successes in the head-hunt, and gloats over his barbarities as they rise bloody before his mind's eye.

Ruthless as Procrustes appears to be, it is highly probable that his barbarous state of mind is not in any great degree exceptional, but may rather be taken as a fair example of the mental and moral condition of most of the healthy boys of his time of life now growing up in this country. At first sight, this may seem far too disparaging an opinion of the moral nature of boys; and unquestionably it is a lower view than that reflected in the juvenile magazines and Sunday-school books. Yet some consideration, I think, will show that it is nearly correct.

Almost every father whose family contains two or three healthy boys under the age of fifteen, certainly every teacher in a boys' school, unless he altogether fails to reach the hearts of the youngsters around him, must feel, after reading a volume or two of current children's literature, that his own boys lack the tender sympathy, the overflowing compassion, which it is now the fashion to impute to the heroes of juvenile fiction. Those persons who are not in a position to come in contact with the children of to-day need only to recall to memory the scenes of their own childhood in order to find repeated episodes in which a suffering kitten or puppy was the central and unpitied figure. The callousness of the children of one's own circle will be made evident after a few minutes spent in such clarifying (though, to sensitive people, rather annoying) introspection; and what is true of one circle in this regard is approximately true of all. My own conviction is, that healthy boys under fifteen feel very little compassion for any suffering but that of their near relatives, their close friends, and occasionally their pet animals. Not only do they evince little compassion, but they often show more than an entire apathy, even an actual pleasure, at the sight of pain inflicted upon animals; and some, with whom we need not now concern ourselves, take a delight that to grown people seems almost fiendish in tormenting their weaker playfellows.

Of course, there are to be found instances, as rare as they are delightful, of highly sympathetic children; but such are to be discriminated from the ordinary run of boys. The children who habitually show this spirit are to be reckoned as moral prodigies, far above the common level; and they are no more to be compared in point of morality with ordinary healthy boys than in point of intellectual power John Stuart Mill, reading Lucan and Plato in his eighth year, is to be compared with the primary pupils struggling through the mysteries of "carrying" and "borrowing." Boys of fourteen who share our feeling of pain at the useless shooting of a bluebird, who have no instinctive impulse to maim a ground-squirrel by a well-aimed shot from a sling, are examples of moral precocity. Like intellectual precocity, this may be very enjoyable to the family in which it occurs; but the probability is, that it is the accompaniment of some unhealthy state, which may be entirely unobserved by the child's admiring but undiscriminating friends. On the subject of intellectual precocity, thanks to the able and tireless efforts of the apostles of the "new education," many people now have sound notions, and the more sensible mothers and fathers among us no longer desire to model their boys after the pattern of the young Macaulay or Pascal. Indeed, not a few of them have come to so enlightened a state that they actually feel some wholesome alarm lest their "intellectual early risers," as Professor Huxley has wittily said, should "be conceited all the forenoon of life and stupid all the afternoon." But, while the judicious have thus become satisfied to see a child's mental powers rise slowly and healthily from the first faint glimmer of intelligence to whatever degree of vigor and brilliancy his endowment may enable them to reach, yet very many people whom we can not class among the Bœotians, and who count most of the authors of children's literature among their number, seem confidently to expect a boy's moral nature, long before his legs have outgrown his knickerbockers, to burst forth with almost the fervor of Mr. Bergh's ebullient conscience. Doubtless they are inexpressibly shocked when they learn, as in the course of things they soon must, that the humane inpulse is as soundly dormant in the breast of their ten-year-old offspring as in the bosom of a Fuegian or a Guacho.

But, when all the circumstances are considered, it will perhaps appear that moral precocity is no more to be desired than intellectual precocity, because the existence of either indicates that the development of the child in which it appears is abnormal. An early appearance of the sympathies depends upon an early development of mental functions, which properly are dormant until later in life; and precocious emotion is an unnatural state, produced by an unnatural and therefore unhealthy development of the brain. Consider for a moment what the seat of the emotions—the brain—is. Like all the other organs of the body, the brain grows from a few simple cells, and reaches its fullness and complexity as the organ of mind after passing through numerous simpler conditions. Like the other portions of the wonderful machine in which each of us lives, moves, and has being, the brain is subject to the all-embracing law of animal existence, which declares the development of the individual to be an epitome of the development of his race. By way of illustration, it is well to note the well-established and now familiar fact that man in his prenatal life goes through several stages, in which he may be successively described as a moner, an ascidian, a fish, a reptile, and a mammal. The entire series of forms through which he passes is so varied that a description of his embryonic existence is almost an epitome of the animal kingdom. And after the appearance in the world of the infant poet or sculptor, he bears in his countenance the marks of his descent from savage ancestors, whose low and ugly forehead, flat nose, and cavernous nostrils are reproduced in his infantile lineaments.

The brain, being merely one of the bodily organs, shares in the growth of the whole organism, and must consequently be weak and undeveloped in its early stages. It becomes stronger only by slow degrees, and in the healthy child it is, as we should expect when we consider his ancestry, the mind of a savage. The civilized child, like the adult savage, has no abstract ideas, and his words number only a few hundreds. One of the writers quoted by Lubbock, in speaking of the intellects of savages, says, "A short conversation wearies them, particularly if questions are asked that require efforts of thought or memory." Such a description, as every teacher knows, is most applicable to our own children, and illustrates how closely their mental state approaches that of the savage. An extremely close observer, Mr. Francis Galton, in reference to some of the lower tribes of Africans, makes the striking remark that "the motives of an adult barbarian are very similar to those of a civilized child."

These facts being granted, it is most instructive to notice how our every-day experience of children's ways points to analogies to the emotions of savages. How complete and how savage is that disregard for filth against which the careful housewife has daily to struggle to accomplish the "shining morning face" she sends away to school! With what a barbarous gluttony does the boy gorge himself with cake, like the Eskimo who forced his wife to stuff him with blubber until he fell down unconscious!

Turn now from these unpleasant traits to that of cruelty, with which we began this discussion. Cruelty seems to be a fundamental fact in the nature of children; but, when we recall the course and the law of man's development, we find nothing depressing in the existence of this savage quality in our boys. As one of the inevitable accompaniments of the savage state, we should expect to find heartlessness among children. "There can be no doubt," says Sir John Lubbock, perhaps the highest authority on the subject of the qualities of barbarians—"there can be no doubt that, as an almost universal rule, savages are cruel." Their moral code permits, if it does not inculcate, revenge and murder; and no stigma whatever is attached to a deed so unnatural to our eyes as maternal infanticide. The stories of inhumanity with which modern travelers fill their volumes, if true of the savages of to-day, will serve to characterize the savages of the past; and there is no fact better established than that the savages of times gone by numbered among themselves our own ancestors. During countless thousands of years, from the unknown date when the Miocene drifts covered the valleys of Western Europe, and buried the war-axes of the inhabitants who hunted beasts and men through the forest, to a time which, in comparison with that date, is as near as yesterday, the ancestors of the present civilized races roamed about as hungry, ill-clad savages. Their daily need of food was supplied by means of the suffering they inflicted upon cave-bears and musk-oxen, and sometimes they slew and ate their fellow-men, and cleft their bones for marrow. The shedding of blood, as the almost inseparable accompaniment of the satisfaction of the most imperious of all desires, hunger, must have become, according to the well-known principle of the association of ideas, in itself a pleasure. Like the savages of to-day, those fierce progenitors of ours must have delighted in the torture of captured enemies. Thus, during long ages, compassion was unknown, and it appears to have been lately acquired by the now dominant races. Indeed, even among so highly cultivated a people as the Romans, it remained almost unknown until comparatively recent times—say fifteen hundred years ago—in proof of which may be noted their heartless fondness for the bloody sports of the arena.

The emotion of pity, then, appeared late in the history of the race; and, in view of the law of our development, which carries us along the path our ancestors have trod, how can we expect our boys to be anything else but cruel? How far is it judicious to go, in trying to alter the natural course of a child's mental growth by imposing upon him ideas which in due course he will not share until later? This last question is inviting, but we will not go into its solution at present, contenting ourselves with observing that because a boy shows no compunction at giving pain to a captive bird, or calmly lacerates the feelings of a family of squirrels, merely to give himself a few soon-neglected pets, is no reason for expecting him to grow up a monster of cruelty. And we will further venture to suggest that much of the immorality of boys is a necessary consequence of their descent, as a corollary of which follows the aphorism of my witty friend, "A good boy is diseased."

# FETICH-FAITH IN WESTERN AFRICA.

By H. NIPPERDEY.

WHILE I was living, in 1884, on the shore of the Kuilu-Niadi River, a fetich-tree was shown me during a walk on the left bank of the stream. It was a *Hyphæne*-palm, the trunk of which was bent down from a height of about sixteen feet till it touched the ground. It had also grown in a circle around another tree of the same species that stood straight in such a way as to form a crown around it at a height of about ten feet. Within the circle inclosed by the tree-stem lay an old, weathered elephant-tusk. I thought at first that I would send a report of this curious phenomenon to Europe, but afterward concluded to make a more thorough study of fetiches and the belief in them, and obtain a little clearer light on the subject. I was greatly assisted in my efforts by Hübbe-Schleiden's excellent work on "Ethiopia," which I made my guide in my researches. I propose to communicate in this paper what I have learned concerning the fetiches of West Africa.

The word *fetich* is derived from the Portuguese, in which *feitigo* means a witch. The use of the word is confined to the coast, and its meaning is unknown to the negroes of the interior. Various expressions are in use on the lower Congo—for example, M'kissi for fetich; N'gille-N'gille for the means by which magic power is given to the fetich; M'lungo is a doctor; and N'doshi are beings of a character similar to that of the were-wolves of European popular mythology. It is much harder to explain the nature of the fetich, for the negro himself is not clear on that subject. I therefore fall back on my authorities, Hübbe-Schleiden and Max Müller. The former says that fetichism is not a proper designation for a religion, for Judaism and Christianity have their fetiches as well as the Nature-religions; the word should be used as analogous with a word-symbol or emblem, as Max Müller has shown. If we should say that the cross is the fetich of Christianity, some persons would think we were guilty of blasphemy, but they would be only those who have no real conception of what a fetich is. The phrase is really as far from blasphemy as science is from idle chattering. The confusion of the emblem with the thought represented, of the material with the spiritual, of the visible with the invisible, is not religion, but superstition, whether it be the worship of fetiches or of relics, idolatry or the adoration of saints. Max Müller says: "We may fancy ourselves secure against the fetich-worship of the poor negro, but there are few if any among us who have not their fetich or idol, either in their church or their heart. The negro's religion is not belief in the power of the fetich, but belief in the power of the spirit through which the fetich is of effect."

One important thought in particular is not peculiar to fetich-faith, but is mixed with the religions of most people; but the negro suffers more than any other man from the fear of ghosts. "In the foaming water, in the dazzling lightning, in the murmuring wind, he sees the working of self-existing spiritual beings. And why should we deprive an anxious human heart of the comforting faith that a piece of hide or a dried snake-head carefully wrapped up and worn about the body can protect him?"

Every Congo negro carries a M'kissi upon himself; and there may be thousands of kinds of them that escape the eyes of the white man. The N'ganga, or medicine-man, is usually the fabricant of the fetich, and whatever he finds good to impose upon his simple-minded, credulous brethren for a high price, sewed up in cloth or leather or inclosed in a goat's horn, is doubly valuable in the eyes of its new possessor, because he believes that his M'kissi stands in a personal relation to himself; and he can not be induced to give it up to a white man for any price.—Among these amulets are dried snakes and lizards' heads, little pieces of skin, feathers of certain birds, and parts of known poison-plants. The eye-teeth of leopards are an exceedingly valuable fetich on the Kroo coast, and it is easy to buy with them articles of vastly more real value, like ivory rings, etc. The Kabinda negroes wear a little brown shell, very much like our *Linnæus*, on their necks. The shells are sealed with wax, and are made, perhaps, vessels containing magic medicines. The large snail-shells found in the Cassava or Manioc fields on the Kuilu Niadi are also M'kissi, and are set in the fields by the women who till them to protect their plantations. One of the chiefs in the upper Kuilu Niadi, in N'kuangila, has a M'kissi against the tornado: it is an antelope-horn. On the approach of a storm the king calls his people together; the horn is stuck in the ground, and a dance is begun around it, which is kept up, in spite of wind and rain, till the tornado is over. Every house in the village has its M'kissi; they are frequently put over the door or brought inside, and then they protect the house from fire and robbery. These penates of the negroes are sometimes figures very artistically cut in wood or ivory, and show a certain degree of native skill and taste in the people. But it is not the guardians of his house only that the negro thus represents in material figures; he also gives corporeal form to diseases, like small-pox, syphilis, and fever. Every town has its war-fetich; and the principle of creation is represented in male and female M'kissi. The *Hyphæne* palm-tree on the Kuilu shows how the negro sees a spirit at work in the wonders of Nature which he can not explain. That tree was M'kissi to the whole village. Good medicines with which the negroes are acquainted, or of which they experience the salutary effects, are also called M'kissi. A negro called a dose of castor-oil which I gave him, *M'kissi mbote*, or good medicine.

The white man—*mondela* or *mundele*—is regarded by tribes which have seen only a few of the white race, as a fetich, and is feared by them, especially by their women and children, as if he were a ghost. On a journey between Isangile and Manzanger I saw a negro who had covered his whole body with white colors. He was a senator of that secret society of which the N'ganga is chief. These people speak their own secret language, and exercise to a certain extent over the other negroes the office of policemen. Every negro has to turn away from them, because it is believed that the women and children, at least, who look upon one will die. In Wunde I saw in the fetich-house the life-size photograph of a white woman sewed upon a red cloth. It was, as I afterward learned, a part of the effects of a servant of the association who had died on the Congo. I especially remarked, while I was living on the Congo, that photographs are among the things which the negroes most readily steal, and that they take them whenever they can get their hands upon them.

A few words, now, on the fetich-doctor or medicine-man, the N'ganga of the negro, who is also his priest, physician, and chief-justice. If any one in the village dies, the negroes, who can not comprehend that any one should die a natural death, believe that he must have been killed by enchantment or by the evil influence of some other person; in short, that another person was the cause of his death. It is the N'ganga's business to find out who this person is. He consults with the spirits by moonlight, and communicates the result of his interview to the people. The accused person is then subjected to the trial by *cassa*. Cassa is the bark of a large tree, the *Erythrophtæum Guineense* (*Leguminosæ Cæsalpineeæ*), and contains a very strong poison. The delinquent is forced to drink a solution of this bark, which has been prepared by the N'ganga. If he vomits the draught up immediately, he is innocent; but, if it remains in his stomach, he must die. In this case the negroes never wait for the operation of the poison, but fall upon him with sticks and stones, or drive the life out of him in some still more savage way. The issue of the trial by cassa of course lies with the N'ganga, and, if the delinquent can pay enough, that functionary will probably save his life. At one time, the king of a village on the upper Kuilu was very sick. The N'ganga quietly ordered a grand dance, with immense noise, to drive away the evil spirits of the royal sickness. The whites, who had a station in the vicinity, could not sleep at night for the din, and therefore, calling up the N'ganga, offered him several pieces of cloth if he would stop the dance. The N'ganga took the cloth, and there was no more dancing. Such is the N'ganga, the great medicine-man of the negroes. If any one asks whether the missions, of which there are now several on the Congo, can not exert an influence on the fetich-faith of the negroes, I would answer that an influence is possible, but only, I believe, by substituting for the present fetiches other Christian objects such as I saw in the French mission at Laudana, where the converted youth wore little figures of saints on their necks. It will be very hard to take the fetich-faith entirely away from the negroes. It is too deeply lodged in their natures.—*Translated for the Popular Science Monthly from Das Ausland.*

## WHAT AMERICAN ZOÖLOGISTS HAVE DONE FOR EVOLUTION.*

By Professor EDWARD S. MORSE.

ELEVEN years ago I had the honor of reading before this Association an address in which an attempt was made to show what American zoölogists had done for evolution. (See "Popular Science Monthly," Vol. X, pages 1 and 181.) My reasons for selecting this subject were, first, that no general review of this nature had been made; and, second, that many of the oft-repeated examples in support of the derivative theory were from European sources and did not carry the weight of equally important facts, the records of which were concealed in our own scientific journals. Darwin was pleased to write to me that most of the facts I had mentioned were familiar to him; but, to use his own words, he was amazed at their number and importance when brought together in this manner. The encouragement of his recognition has led me to select a continuation of this theme as a subject for the customary presidential address, a task which is at best a thankless if not a profitless one. Had I faintly realized, however, the increasing number and importance of the contributions made by our students on this subject, I should certainly have chosen a different theme.

Incomplete as is this record of ten years' work, I am compelled to present it. In the Buffalo address two marked periods in the work of the zoölogists in this country are recognized: the one period embracing the work of the topographers, the field-surveyors in the science; the other period dating from the advent of Agassiz, with the wonderful impulse he imparted to the study by his enthusiasm and devotion. A third period in American zoölogical science, and by far the most important awakening, dates from the publication of Darwin's "Origin of Species." Its effect on zoölogical literature was striking. The papers were first tinged with the new doctrine, then saturated, and now, without reference to the theory, derivation is taken for granted.

As zoölogists we are indebted to Darwin for the wide-spread public interest in our work. Before Darwin the importance of our special studies was far outweighed by the practical value placed upon science, in the application of which an immediate material gain was assured. Chemistry, physics, geology were important to the public only because

* Address of the retiring President of the American Association for the Advancement of Science, delivered at the New York meeting, August 10, 1887.

a practical application of these sciences was capable of showing an immediate material return.

Agassiz, in his appeal to the State for appropriations for the great museum at Cambridge, insisted that there were higher dividends than those of money to be looked for in endowments for zoölogical museums, and these were intellectual dividends. While the force of this appeal will always remain true, the transcendent importance of the naturalist's studies from the standpoint of Darwin is widely recognized. Man now becomes an object of rigid scientific scrutiny from the new position which has shed such a flood of light upon the animals below him. His habits, behavior, the physical influences of his environment and their effects upon him, transmission of peculiarities through the laws of heredity—all these factors are directly implicated in the burning questions and problems which agitate him to-day. Questions of labor, temperance, prison reform, distribution of charities, religious agitations, are questions immediately concerning the mammal man, and are now to be seriously studied from the solid standpoint of observation and experiment and not from the emotional and often incongruous attitude of the Church. To a naturalist it may seem well-nigh profitless to discuss the question of evolution since the battle has been won, and if there be any discussion it is as to the relative merits and force of the various factors involved. The public, however, are greatly interested in the matter, as may be seen by a renewal of the fight in the English reviews, and the agitation is still kept up by well-meaning though ignorant advisers, who insist that Science has not yet accepted the doctrine ; and great Church organizations meet to condemn and expel their teachers of science from certain schools of learning because their teachings are imbued with the heresy.

Dr. Asa Gray,* in his discriminating biographical memoir of Darwin, says, in regard to the "Doctrine of Descent": "It is an advance from which it is evidently impossible to recede. As has been said of the theory of the Conservation of Energy, so of this : 'The proof of this great generalization, like that of all other generalizations, lies mainly in the fact that the evidence in its favor is continually augmenting, while that against it is continually diminishing, as the progress of science reveals to us more and more the working of the universe.'" Let us examine, then, the evidences, trivial as well as important, that have been recorded by American zoölogists within the past ten years in support of the derivative theory.

Without further apology for the very imperfect character of this survey, let me at once begin by calling attention first to the testimony regarding the variation in habits and evidences of reasoning power in animals. The establishment of individual variation in mental powers, change in habits, etc., lies at the foundation of Darwinism as furnishing material for selective action. There is no

* "Proceedings of the American Academy of Arts and Sciences," vol. xvii, p. 449.

group of animals which exceeds the birds in varied and suggestive material for the evolutionist. It is a significant fact that the birds, which appeared to Cuvier and his contemporaries a closed type, a group that seemed to fulfill the ideal conception of a class archetype, as compared with other groups which had their open as well as obscure relationships, should be of all groups the one that first yielded its exclusive characteristics. In fact, there is no group in which the barriers have been so completely demolished as in this apparently distinct and isolated class. An attentive and patient study of the birds has established almost every point defined by Darwin in his theory of natural selection. One has only to recall the marked reptilian affinities as shown in their embryological and paleontological history. Besides all these structural relationships, the birds possess as a group remarkable and striking illustrations of variation in color, size, marking, nesting, albinism, molting, migration, song, geographical variation, sexual selection, secondary sexual characters, protective coloring; and in their habits show surprising mechanical cunning and ingenuity, curious and inexplicable freaks, parental affection, hybridity—indeed, the student need go no further than the birds to establish every principle of the derivative theory.

The many observations on the nesting habits of birds would form a curious chapter as illustrating the individual peculiarities of these creatures.

Dr. A. S. Packard* records the fact, as related to him by Mr. Wyatt, of wild geese nesting in large cottonwood-trees on Snake River, west of the Rocky Mountains; and Dr. Coues, in his "Birds of the Northwest," says wild geese "nest in various parts of the Upper Missouri and Yellowstone regions in trees." Mr. H. W. Turner † observes a robin nesting on the ground. The late Dr. T. M. Brewer ‡ points out some very curious "variations in the nests of the same species of birds." He not only observes individual variation in nest-structure, but shows that in different regions of the country birds of the same species build different kinds of nests, and in reflecting on these peculiarities he is led to say, "If we can not understand what it can be that stimulates an *Empidonax* in Staten Island to build a pensile nest, while its fellow in Indiana builds one like a deep cup and surrounded with thorns, and another group in Pennsylvania put theirs on an exposed tree-top, and so flat that the eggs seem liable to roll out, we must see that some cause, hidden to us, is gradually effecting changes that sooner or later may become universal in the species, though which it is to be we may not be able to imagine."

Mr. J. A. Allen, # in writing on the inadequate theory of birds' nests, shows grave and important exceptions to Wallace's theory, though he subscribes heartily to his philosophy of birds' nests. He

* "American Naturalist," vol. xii, p. 54. † Ibid., vol. xii, p. 53. ‡ Ibid., vol. xii, p. 35.

\# "Bulletin of the Nuttall Ornithological Club," vol. iii, p. 25.

expresses surprise that closely allied species of birds should oftentimes build divers kinds of nests, overlooking the fact that even closely allied varieties of man build entirely unlike houses.

Mr. F. H. Knowlton* records a cliff-swallow appropriating, for the construction of its own nest, pellets of mud which were being brought by another swallow. Also the curious fact that a number of swallows were observed busily engaged in sealing up a nest in which one of their comrades lay dead. Among the curious traits of birds, Mr. H. B. Bailey † communicates some new ones observed in the red-headed woodpecker by Mr. Agersborg, of Dakota Territory. This gentleman had observed one of these birds wedging grasshoppers in a large crack of an old oak-post. Nearly a hundred were stored away in this manner, the bird afterward feeding at leisure on the supply. This parallels the habit of the California woodpecker storing acorns in holes in the tree and subsequently feeding on the fully developed larvæ within the seed.

Mr. O. P. Hay,‡ in a late number of "The Auk," has an interesting paper on the red-headed woodpecker as a hoarder, showing that the bird makes accumulations of beechnuts, pounding them between the shingles of a roof, wedging them into crevices, and storing them in cavities in trees.

The plausible suggestion made by Darwin as to the agency of aquatic birds in the wide dispersal of fresh-water mollusks, was singularly confirmed several years after by Mr. Arthur F. Gray shooting a duck which had clinging to one of its toes a fresh-water mussel. Dr. J. W. Fewkes # has recently recorded the shooting of a duck in Sebec, Maine, which was in like manner transporting a fresh-water mussel. The same bird had been observed several days before with this curious companion clinging to its foot, and had the duck been migrating at the time it might have transported the mussel many hundreds of miles. In this connection it would be an interesting inquiry as to how far the similarity observed in north temperate and circumpolar animals is due to the annual migration of birds north and south.

Mr. William Brewster ‖ notes some interesting features in the habits of a young Kittiwake gull of the St. Lawrence. He brought home a young one, its mate having died of thirst, the other one surviving through the accidental discovery that the bird drank only salt-water! Both the birds obstinately refused to drink fresh water. Observations on this bird by Professor A. Hyatt showed how slowly and timidly it acquired the art of swimming and flying. The bird when first forced to fly was thrown into the air, and, to the surprise of Professor Hyatt, flew with great rapidity and precision, circling about the house and through the apple-trees, and, finally, flew near him several times in

* "Bulletin of the Nuttall Ornithological Club," vol. vi, p. 55. † Ibid., vol. iii, p. 97.

‡ "The Auk," vol. iv, p. 193. # Ibid., vol. i, p. 195.

‖ "Proceedings of the Boston Society of Natural History," vol. xxii, p. 364.

the greatest agitation till he caught the bird, which was completely exhausted. For a long time the bird went through this manœuvre, showing that while he knew how to fly it could not alight, though it finally acquired this faculty. Professor L. A. Lee * records a remarkable attack made on him by a marsh-hawk, and Mr. Abbott M. Frazer † tells of a tame crow deliberately standing on an ant-hill and permitting the ants to remove the parasites from its feathers. In this connection a paper by Mr. Joseph F. James ‡ should be read, in which he shows by a number of arguments that animals not only present a reasoning faculty, but that this faculty has been the result of slow evolution.

Mr. Xenos Clark,# in an exceedingly interesting article on the music of animals, and particularly the music of birds, concludes by saying there is "a theory for the origin of melody, whether human or extra-human, which, besides the usual basis of physiological acoustics, employs the law of modified, inherited, selected, and adapted structure—i. e., the law of evolution."

Mr. Ruthven Deane ‖ records cases of albinism and melanism in a great many families of birds; and Mr. N. C. Brown △ shows the variable abundance of birds at the same locality in different years. In this connection it will be of interest to read Dr. L. P. Gratacap's ◊ paper entitled "Zoic Maxima, or Periods of Numerical Variations in Animals."

The behavior of wild birds when kept in confinement, and the attempts made in domesticating them, have always furnished an interesting field for study. The curious freaks and impulses which they often betray, the changes they show under the new conditions, indicate in some measure the plasticity of their organization.

Hon. John D. Caton,‡ in an interesting paper on "Unnatural Attachments among Animals," records a curious fondness shown by a crane for a number of pigs; and in another paper on the "Wild Turkey and its Domestication," ↕ this writer has made some valuable records of the successive changes which take place in the bird during this process: changes in color, during which the more conspicuous features of protective coloring are lost; changes in habit, in which is seen the undoing or relaxing of those features which indicate constant vigilance, from carrying itself in a semi-erect attitude, perching on the tallest trees, covering up the eggs carefully with leaves when off the nest, etc., to moving in an horizontal attitude, perching near the ground, covering the eggs but slightly, or carelessly, etc., and losing that wildness which characterizes the bird in its wild state. At the breeding season, however, the females became wild again, but this was a feature too deeply implanted to show modification in the time allotted to Mr.

* "Bulletin of the Nuttall Ornithological Club," vol. v, p. 186. † Ibid., vol. i, p. 76.

‡ "American Naturalist," vol. xv, p. 604. # Ibid., vol. xiii, p. 209.

‖ "Bulletin of the Nuttall Ornithological Club," vol. i, p. 20. △ Ibid., vol. i, p. 15.

◊ "American Naturalist," vol. xx, p. 1009. ‡ Ibid., vol. xvii, p. 359.

↕ Ibid., vol. xi, p. 321.

Caton's experiment. The same writer * has also observed in the Hawaiian Islands the effects of reversion to a wild state of different kinds of domestic animals which have from time to time been carried there. Among other animals he was fortunate enough to observe the undoing stages in the domestic turkey and the assumption of those features which characterize the wild bird.

A great many facts illustrating the plainest features of natural selection, protective coloring, mimicry, etc., have been recorded in our journals from time to time. A brief allusion may be made to a few of these.

Professor Samuel F. Clarke † notices a pronounced case of natural selection, a case which must often occur in nature. He kept in large glass jars masses of eggs of Amblystoma. As soon as these eggs began to hatch he found it difficult to provide the young with suitable food, and yet they seemed to thrive. On examination, many of them were seen to be engaged in nibbling the branchia of others, and as they increased in size they were seen to swallow the weaker individuals bodily and hence grow with increased rapidity. "Here, then," he says, "was a very interesting case of natural selection by survival of the fittest, all the weaker individuals being destroyed and actually aiding the stronger ones by serving them as food until they could pass through their changes and escape to other regions where food was more abundant." Professor B. G. Wilder has recorded a similar condition of things in a species of spider where the young spiders within the case inclosing the eggs were feeding on the weaker ones. Professor Henry L. Osborn ‡ observes a curious case of mimicry at Beaufort in the coloring of a species of Ovulum which frequents a species of Leptogorgia. The Ovulum was yellow in color on the yellow variety of this sea-fan, and purple when living on the purple variety. Dr. R. E. C. Stearns # has made some interesting notes on protective coloring in *Phrynosomæ*. Having collected these horned lizards (or toads as they are commonly called) in Central California, he has noticed that if the ground region they frequent is yellowish, the lizards are without exception of that color; if ashen-gray, then that color is simulated, and this without exception. Further than this he is "led to believe that a sufficient number of living specimens will show a similar protective factor in degree of development of the scale imbrications, tubercles, so called, and horns—or, in brief, in the sculpture aspect as related to the surface texture of the ground which forms the local habitat of these forms." Dr. A. S. Packard ‖ has observed the partiality of white butterflies for white flowers. He notices the European cabbage-butterfly, which is white, go directly to the white aster and rarely visit the golden-rod; while the yellow sulphur butterfly vis-

* "American Naturalist," vol. xv, p. 955.

† Ibid., vol. xii, p. 615.

‡ "Science," vol. vi, p. 9.

\# "American Naturalist," vol. xvii, p. 1077.

‖ Ibid., vol. xi, p. 243.

its the yellow flowers of the golden-rod oftener than those of the aster. The same author* also observed a harmless Egerian moth which deceived the sharp eye of a trained entomologist by its resemblance to a wasp, and asks why a bird may not be equally deceived. Miss Sarah P. Monks † observed a case of mimetic coloring in tadpoles, their tails precisely resembling the leaves of an aquatic plant, Ludovidgia.

Miss Mary E. Murtfeldt ‡ having noticed that the butterfly, *Pyrameis Hunteri*, always deposited its eggs on the plant Antennaria, she was surprised to find a number of larvæ of this butterfly on Artemisia. The customary plant being rare in the immediate vicinity, the butterfly had been misled by the surface resemblance of the white, cottony leaves of the Artemisia to those of the accustomed food-plant. In this case the larvæ all died.

An unquestionable fact has been finally established by recent methods of observation on the habits of insects and other animals, and that is that individuals of the same species vary in intelligence; that they are not automata; that they are not impelled by a blind instinct to perform certain acts with unerring accuracy, but, on the contrary, that they vary and often greatly vary in their ability to provide for their young, in their skill to secure sufficient food, in their wit to avoid danger—in other words, they make blunders and mistakes and involve their progeny and even their colony in ruin. This individual variation in intelligence is brought out very clearly by a patient series of observations made by Drs. G. W. and E. G. Peckham # on the special senses of wasps. They not only repeated many of the experiments of Sir John Lubbock, but many new and ingenious experiments were devised. Their studies were for the purpose of investigating the mental power, sense of hearing, color, direction, memory, emotion, power of communication, general intelligence, etc. An interesting result of their painstaking work was the determination of individual differences as to the faculty of memory and power of distinguishing color and direction. This kind of study of the habits of insects has brought to light features of the most surprising character. The remarkable studies of Sir John Lubbock, Dr. Moggridge, and others in Europe, have been paralleled in this country not only by the observations above quoted, but notably by the labors of Rev. H. C. McCook ‖ in his studies of the American ants and spiders. In various papers published in the "Proceedings of the Philadelphia Academy of Natural Sciences" and in the "American Naturalist," he has shown many extraordinary and curious features in the life-histories of these animals. The great variety and extent of his work must be my excuse for not referring to it in detail.

Professor G. F. Atkinson,^ in studying a new species of trap-door

* "American Naturalist," vol. xiv, p. 600.

† Ibid., vol. xii, p. 695.

‡ Ibid., vol. xvii, p. 196.

\# Historical Society of Wisconsin.

‖ "American Naturalist," vol. xii, p. 431.

^ Ibid., vol. xx, p. 583.

spider, confirms the observations of others as to the creature deliberately attaching fragments of moss to the lid of its nest in order to conceal its position. Dr. Thomas Meehan* describes a hornet that was gifted with great intelligence. He saw this insect struggling with a large locust in unsuccessful attempts to fly away with it. After several fruitless efforts to fly up from the ground with his victim, he finally dragged it fully thirty feet to a tree, to the top of which he laboriously ascended, still clinging to his burden, and having attained this elevated position he flew off in a horizontal direction with the locust. Dr. Meehan truly says, "There was more than instinct in this act, there was reasoning on certain facts and judgment accordingly, and the insect's judgment had proved correct."

A curious case of circumspection in ants is recorded by Dr. Joseph Leidy.† In an empty house he observed some ants feeding on crumbs of bread left by the workman. He at once placed pieces of bread in the different rooms in the house only to find them the next day covered with ants, which he destroyed by causing them to fall into a dish of turpentine. After a few days the ants no longer visited the bread, and he supposed they had been exterminated. A few days after, however, he observed a number of ants in the attic feeding on the body of a dead fly. He immediately got a lot of grasshoppers and distributed their bodies in all the rooms, only to find that they were soon covered with ants, which he destroyed as before. This treat continued attractive for a few days only, when the ants abandoned the food. In brief, he tried meat, cake, and various other articles in turn ; the ants for a while frequenting these snares, only to learn the danger involved, and finally avoided them.

The gradual dispersion of species in recent times is of great interest, and careful records should be made of the facts as observed and a collection of large numbers of individuals made, in order to compare them with specimens of the same species in future years, to ascertain the variation which may have taken place and the tendency of that variation. A number of observatians have been published within the last ten years, showing new areas of distribution. *Littorina litorea*, which has been creeping along the coast since 1869, as recorded by Gray, Verrill, and others, has now reached the southern side of Long Island Sound, as observed by Mr. Henry Prime.‡ *Lioplax subcarinata*, an Ohio River species, has been found in the Hudson River at Catskill Landing. *Limax maximus*, first found at Newport, Rhode Island, by Mr. Powel, has since been found at Cambridge, Massachusetts, by Professor Hyatt. *Bythinia tentaculata*, first recorded from Oswego, New York, by Rev. W. M. Beauchamp,# is reported as having been found at Burlington, Vermont, by G. H. Hudson. In the Mohawk

* "Proceedings of the Philadelphia Academy of Natural Sciences," 1878, p. 15.

† "American Journal of Science and Arts," vol. xv, p. 320.

‡ "American Naturalist," vol. xvi, p. 737.

# Ibid., vol. xiv, p. 523.

River is a thriving community of this species, the first having been placed there by Dr. James Lewis.

Dr. R. E. C. Stearns,* in commenting on the occurrence of *Mya arenaria* in San Francisco Bay, states that the first record of the species in California was made by Dr. Newcomb in 1874. Within a few years it has increased in great numbers, furnishing a new food-supply for the people. The evidence that it is a recent introduction is seen in the fact that so large and conspicuous a species could not have escaped the eye of the collector. No trace of it has ever been found in the numerous shell-heaps of California, though it is found on the Asiatic coast, from Kamtchatka to the southernmost limits of Japan. Dr. Stearns believes it to have been imported with the oyster transplanted from the Atlantic coast. From large numbers of the shells that I measured, the low index would show that it came from some southern point on the Atlantic coast.

The delicate balance of conditions between organisms, whether it be between individuals of the same species or between widely-separated groups, is an important feature in the question of survival. Professor S. A. Forbes,† in a thoughtful study of certain species of entomostraca in Lake Michigan and the surrounding waters, calls attention to the important part played by these minute crustaceans, showing how they furnished almost the entire food for young fishes, larger crustaceans and even insect larvæ. He writes: "Mollusca, one would say, could afford to be indifferent to them, since they neither eat them nor are eaten by them, nor seem to come in contact with them anywhere, through any of their habits or necessities. But for this very reason these two classes afford an excellent illustration of the stringent system of reactions by which an assemblage of even the most diverse and seemingly independent organisms is held together. . . . If there were no entomostraca for young fishes to eat, there would be very few fishes indeed to feed upon mollusca, and that class would flourish almost without restraint; while, on the other hand, if there were no mollusca for the support of adult fishes, entomostraca would be relieved from a considerable part of the drain upon their numbers, and would multiply accordingly." He is much struck with the fact that in the larger bodies of water, the species of entomostraca show an inferior development in numbers, size, and robustness, and in reproductive power. Their smaller number and size are doubtless due to the relative scarcity of food. "The difference of reproductive energy, as shown by the much smaller egg-masses borne by the lacustrine species, depends upon the vastly greater destruction to which the paludinal crustacea are subjected. Many of the latter occupy waters liable to be exhausted by drought, with a consequent enormous waste of entomostracan life. The opportunity for reproduction is here greatly limited—in some situations to early spring alone—and the

* "American Naturalist," vol. xv, p. 362. † Ibid., vol. xvi, p. 537.

chances for destruction of the summer eggs in the dry and often dusty soil are so numerous that only the most prolific species can maintain themselves under such conditions.

"Further, the marshes and shallower lakes are the favorite breeding-grounds of fishes, which migrate to them in spawning-time, if possible, and it is from the entomostraca found here that most young fishes get their earliest food-supplies—a danger from which the deep-water species are measurably free. Not only is a high reproductive power therefore rendered unnecessary among the latter by their freedom from many dangers to which the shallow-water species are exposed, but in view of the relatively small amount of food available for them, a high rate of multiplication would be a positive injury, and could result only in wholesale starvation."

The effect of birds on insect-life has engaged the attention of the same author.* His inquiry was to ascertain whether birds originated any oscillations in the numerical proportion of insects upon which they feed. Many interesting facts are given which space forbids quoting.

A number of contributions have been made on the influence of environment and on geographical variation, to some of which reference must be made. Professor Alpheus Hyatt† bears unequivocal testimony to the derivative theory, and recognizes clearly the influence of external surroundings in a memoir on the cephalopods, when in stating the law of organic equivalence he says: "The action of physical changes takes effect upon the irritable organism, which necessarily responds to external stimulants by an internal reaction or effort. This action from within upon the parts of the organism modifies their hereditary forms by the production of new growths or changes which are, therefore, adapted to the conditions of the habitat or the physical agents and forces from which they directly or indirectly originate"; or, slightly changing this interpretation in accordance with the same facts, each individual is more or less susceptible to the action of physical influences and those which respond most quickly to these influences, come more promptly in harmony with their environment, which is natural selection pure and simple.

Mr. Charles Morris,‡ in a series of papers on "Organic Physics" and the "Polar Organization of Animals," presents many new and suggestive thoughts on the physico-chemical action in life and development. He concludes that "there are inherent in the germ energies and tendencies, chemical, molecular, or whatever we choose to call them, adapted to the complete unfoldment of the typical form. But, as appears evident, their operation can be checked by influences from external nature. There is a struggle between these contact influences and the innate organic tendencies."

* "American Naturalist," vol. xvii, p. 671.

† "Proceedings of the American Associated Antiquarian Society," vol. xxxii, p. 323.

‡ "American Naturalist," vol. xvii, p. 486.

[*To be continued.*]

# THE LANGUAGE OF THE EMOTIONS.

By M. ALFRED FOUILLÉE.

WITH the words "Every gesture is a metaphor," Diderot exactly characterized that translation of the feelings into corresponding movements which we call their expression. But, though the natural language of the physiognomy and of gestures is metaphorical, it need not be inferred that it is composed of symbols in any degree arbitrary. It is rather by a necessary determinism that a particular internal phenomenon is translated by a peculiar external manifestation. Expression is no longer considered a sign that may be detached from the expressed fact; it is an integral part of the fact, or of its history. A man, realizing that his life is in extreme peril and anxious to save it, might, perhaps, be able to preserve his calm; but, as Darwin says, he suffers a tension of his will against his emotion, and the conflict within him is faithfully expressed in the body by the parallel tension of the muscles and the correlative tension of the pulse. Feelings too weak to produce a visible outward expression are marked in the interior of the organs. We should not, then, as the old psychologists did, place the psychological changes and the physiological movements in which they are realized, or prolonged, or expressed, in different worlds.

Darwin attempted a biological explanation of this reciprocally determined connection of the internal feelings with external movements, as arising in the gradual evolution of organisms struggling for existence. Mosso * and Warner † showed that there are physiological and mechanical limitations to the influence of selection and the medium, or that there are internal necessities independent of exterior utility, and assumed that the explanation of the phenomena belongs to physiology. But should not philosophy, we ask, maintain a view yet more of the interior, strictly psychological and sociological? Should it not explain, by the laws of individual or collective consciousness, those facts of expression which are the precise continuation of the mental in the physical and of the physical in the mental? All expression of feeling has, by its definition, a psychological, and, still more, a social, side. There is, in fact, no veritable expression except as there may be a possible interpretation of the movements by other beings forming, with the first one, a society. The language of the passions is eminently communicative. Every living organism is, moreover, itself a society of more elementary organisms, and it is therefore legitimate to inquire if the act of social communication does not begin within the organism itself before extending to other analogous organisms; if there is not a solidarity, at once mechanical and mental, between the parts of the identical organism—

* Angelo Mosso, "La Paura," 1885.  † Warner, "Physical Expression," 1886.

brain, heart, and muscles of the face—before the passion is communicated to the other organism. All the acts of expression are, we think, best explained by this physiological and sociological law of solidarity and sympathy.

According to Darwin's theory of explanation, our expressional movements are habits, which, useful at first for the maintenance or defense of life, are preserved and transmitted after they no longer have immediate utility. Most of our gestures are of this class. The signs of affirmation and negation appear to have come from the infant's inclining its head to receive nourishment from its mother's breast, and turning it away when it does not want food. The same gestures, applied to all affirmation and negation, have become hereditary and instinctive with many nations. The acts of clinching the fists and displaying the teeth were primarily voluntary, as preparations for combat and signs of defiance of the enemy ; they then became associated with the feeling of anger, then transmitted by heredity, till now we clinch our fist when the enemy is not present, and express the sneer of contempt by an exhibition of the teeth, joined with a backward motion of the head, but with no thought of biting.

However extended the effects of heredity may really be, we have a right to reproach Darwin for having given too great a part to the external causes, to selection and the medium. It is in the very tissues of the organism, in the inmost properties of the living substance, that we should first seek for the mechanical and physiological reasons for the phenomena of expression. Thus, the contraction of the eyebrows in struggle and in pain, which is explained by Darwin as a survival of a movement originally advantageous in combat, is shown by M. Mosso to be a result of the flow of blood to supply the waste of nervous force, and to be physiologically connected with movements of attention and of effort.

In the physiological view, the law that links the emotion with its exterior signs is the same that governs all the manifestations of life and force ; it is the law of the equivalence of movements. At any particular moment, the quantity of nervous force corresponding to the state of consciousness called sensation has to expend itself in some way, and engender somewhere an equivalent manifestation of force. The expended force may itself follow three different courses. Sometimes the nervous excitation is transformed simply into cerebral movements corresponding with a mental agitation. This is what takes place, for example, when a child hears a story that interests and moves it. At other times the nervous excitation is transformed into movements of the viscera, and follows the ganglionic nerves. Agreeable thoughts, for example, aid digestion. Fear may paralyze the nerves of the intestine. The heart beats more rapidly under emotion, and sometimes stops, and this influence is accomplished through the means of the pneumogastric nerves. Or the nervous excitation, following the motor nerves, is transformed into movements of the muscles, which then become the exterior and visible signs of the emotion. A burn on the finger produces a contraction of the features. A lively joy or a deep disquiet throws us into a condition of agitation and purposeless talking and moving about. If the emotion is concentrated, the cerebral disturbance increases in violence as the muscular agitation diminishes. When we spend the excess of our agitation in external movements, in gestures, walking back and forth, tears, and lamentations, the cerebral agitation is correspondingly diminished. These phenomena of diversion are nothing else than particular cases of the conservation of force and the propagation of movements. Sometimes the propagation results in a real metamorphosis. Very violent emotions, producing a reaction on the central parts of the innervation, bring on a sudden paralysis of a number of muscular groups, while feeble disturbances of the sensibility produce superexcitation, which is subsequently replaced by exhaustion. This is what Wundt calls the law of the metamorphosis of nervous action. There result from it effects of balancing and compensation which, in our opinion, are still simply an application of the law of equivalence between movements.

M. Mosso's physiological explanations usually revert into Wundt's law, and with stronger reason into the general law of the equivalence of forces. He has shown that cerebral excitation makes the blood flow to the brain, and that, during intellectual labor, the afflux is sufficient to diminish the volume of the arm. He observed the circulation of the blood in three subjects whose craniums had been partially destroyed. Whenever a stranger came in, or a sudden noise was heard, the cerebral pulse rose immediately. Under the influence of fear the blood flows back to the extremities, to such an extent that a ring can not be pulled off from the finger. M. Mosso has also applied the balance to the study of the circulation. A man is laid full length in a wooden box, arranged as a balance upon a knife-edge, with apparatus for marking the trace of the pulse in the feet and hands, and the changes of volume undergone by these organs. When the balance and the man in it are in equilibrium and repose, something is said to the man. Instantly, by the effect of the excitation received and the attention responding to it, the balance inclines toward the man's head.

Mr. Warner has carefully studied the effects of the emotions in nutrition, which he calls the trophic signs. Maladies that modify nutrition also modify the nervous system, and render it more irritable. The poorly-nourished child often has what the doctors call the nervous—that is, shaky—hand ; a more reduced nutrition may end in chorea. Plants also afford examples of excessive irritability, arising from imperfect nutrition. Some sensitive plants were sowed in clear sand, and others in vegetable mold mixed with sand in different proportions. The first, which had nothing but air to feed upon, languished and died ; they were extremely sensitive to the lightest touch ;

a breath, or a slight motion of the pot made them droop. Those plants which had a third or two thirds of vegetable mold were still irritable, but in a less degree, and would not bloom. Those which had pure vegetable earth became robust and nearly insensitive; striking their leaves with a stick, would make them double up, but they would unfold again almost in an instant.

Besides the general excitation of the cerebral centers, the ganglionic nerves, the circulation, and nutrition, emotion produces a general excitation of the motor nerves and the muscles. According to Mr. Spencer, the excitation of the muscular system should be proportional to the intensity of the feeling, whatever may be its character in other respects; a great joy, like a great grief, should move the whole body. Moreover, Mr. Spencer adds, the force of the passion affects the muscles in the inverse ratio of their size and of the weight of the parts to which they are attached. With the dog and cat, the mobility of the tail makes it capable of furnishing, from its origin, the indication of the rising feeling. The greater or less elevation of the tail is a sign of pleasure; its sidewise beatings, of uneasiness. With man, the muscles of the face are relatively small and very mobile, and for this reason the countenance is the best index of the degree of intensity in feeling; and the ear, motionless in man, is a marked organ of expression in the horse.

The real defect of the theory expounded by Mr. Spencer is, that it is too purely physiological; it has not taken sufficient account of the different effects produced according as the emotions are agreeable or painful. According to his view, the energy of the feeling, whatever may be its nature, is always manifested by an energy of movement. We dance, he says, with joy, as we stamp with rage; we can no more keep still under moral distress than in the exaltation of delight; there are cries of anguish as well as notes of pleasure; and frequently the sounds uttered by children in their sports leave parents in doubt whether vexation or pleasure is their motive. Granted; yet these various manifestations of activity have a resemblance only in the eyes of a distant or superficial spectator. It is hard to suppose that pleasure and pain are primarily manifested by an identical general augmentation of activity.

If the physiologists had considered the emotions in their psychological elements, they would have been better able to account for their manifestations, and would not have involved themselves in an inextricable confusion. In all passion there is first an intellectual element—perception or idea; next a sensible element—pleasure or pain; and, finally, a volitional element—desire or aversion. We must, then, to account completely for an expressive motion, seek first the sensitive and mental state which it expresses; second, the affective state; and, third, the corresponding attitude of the will.

Some psychologists, with Herbart, have looked for the primary origin of the emotions in the intelligence, and have sought to explain them by a simple play of ideas. Herbart has made the mistake of having seen only the intellectual effect in passion.

M. Wundt rather sees the force of the will under that of the ideas, but he places this force solely in the attention, in what he calls the *apperception*, or the grasp of objects by the intelligence. Emotion is, then, according to him, in its origin, only the effect produced by the feeling on the attention. He concludes that the elementary emotion is surprise, "which behaves, in regard to the more complex movements of the soul, merely as the æsthetic feeling awakened by a simple geometric form as opposed to the effect produced by a work of art." M. Wundt might have added that surprise is the intellectual analogue of the mechanical shock with its well-known elastic effects.

Whatever part of truth this psychological analysis may include, it does not yet seem to us to reach to the real and primordial elements of the emotion. M. Wundt has not asked whether, instead of leading fright up to a sort of surprise, we can not trace surprise back to a sort of fright. In fact, with the inferior animals, astonishment is hardly anything else than fright—that is, aversion. Every novelty not yet looked into is regarded, until further orders, as a danger; animals have not begun to be curious observers of new things, or innovators, but are still conservatives trembling before the unknown. We can not, therefore, consider astonishment the really primitive emotion.

The study of the physical effects will also help to enlighten us as to the nature of the causes. Surprise is manifested by open eyes, elevated eyebrows, open mouth, and raised hands. The eyes are opened to gain a clearer view of the strange object, and the lifting of the eyebrows is an accompaniment to that movement. The opening of the mouth is a consequence of the relaxation of the muscles caused by the flight of nervous force to the brain, and is also a movement promoting the deeper inspiration which is a requisite to energetic effort, and which accompanies the accelerated beatings of the heart. The raising and throwing back of the hands may be regarded as a cautionary movement.

According to the preceding observations, we should seek the real origin of the movements of expression in the effect of the emotions, not on the intelligence, but on the primary activity and the desire. Now, we know that pleasure is essentially an augmentation of vital activity, while pain is a diminution of it; here, therefore, is the principle from which we should start to look for the motions by which pleasures and pains are translated.

The most rudimentary animals, allied to the vegetable kingdom, without nervous and muscular systems, probably did not have the faculty of moving from one point to another in their abode; but there must have existed, even in these primitive species, some tendencies to a superexcitation or a depression of the general activity depending on the approach or the removal of advantageous or injurious objects. These tendencies, on account of their advantages, are picked out and magnified by natural selection. We may add, with M. Schneider, that the increase of the general activity, even in the absence of a muscular system, is always manifested as expansion, and the decrease of activity as contraction. Expansion and contraction are at the origin of all the other vital movements, and of course of all the signs of expression.

Now let us consider what states of sensibility would correspond among the rudimentary animals with the different modes of general activity, accompanied by movements of expansion and contraction. We shall then have the two following situations: first, approach of an advantageous object, followed by increase of activity beyond the normal state, with pleasure and the movement of general expansion, which is the sign of it; and, second, on the approach of the injurious object, descent of activity below the normal, pain, and the movement of general contraction. With a step further in evolution, the internal movement of contraction, perfecting itself by natural selection, has brought the living being to a massive movement of transport in space, which will take it away from the object—this is the movement of aversion and flight. The movement of expansion, on the contrary, would have provoked a transportation of the whole body of the living being toward the agreeable object—it is the movement of inclination and pursuit. Here are two new signs in the natural language. Add to them the idea of the object that causes the pain or the pleasure, and we shall have conscious repulsion and desire.

These are the primary emotions, with the general movement of the body that expresses them at the first moment. We can say, then, contrary to Mr. Spencer, that, if the intensity of an agreeable feeling is expressed by an exaltation and expansion of motive activity, the intensity of a painful feeling is expressed at once by a contraction and diminution of motive activity. In joy the different organs only reproduce and aid the general movement of expansion; the features dilate, the eyebrows turn upward, the entire physiognomy opens, the voice rises and swells, and the gestures expand in more ample and more numerous movements. We can also say correctly that the lungs dilate, and their play is rendered easier; the cerebral functions are performed with more rapidity and ease; the intelligence is more animated; the sensibility more expansive; the will more kindly. In a word, the expression of joy is a general expression of liberty, and, by that fact, of liberality.

Next, we pass to the immediate expression of pain. At the first moment the depression of activity is manifested by a general depression of the motive force. "The lips are relaxed," says Sir Charles Bell, "the lower jaw drops, the upper eyelid falls and covers half of the pupil, and the eyebrows incline like the mouth." It is true that some other muscles simultaneously become tense, and enter into play, but Mr. Bain has shown that they are the ones the contraction of which is related to the relaxation of the other muscles. "With a little force a greater one is relaxed." The expenditure in this case is made for saving, and takes place, we think, because the first motion in the face of pain being a movement of conservation and concentration on self, is also a tendency to save the force which is felt to be diminishing—we retire from the pain, and try to recover ourselves. The first stage of pain does not last long, for the reaction begins at once. While the will can consent to pleasure, it can not consent to pain. It defends itself, it struggles, against it. After the first stroke of pain that casts down, we perceive the signs of effort. Sometimes the effort is spasmodic, and involves a prodigality of force that can hardly fail to bring on quick prostration.

Suffering and joy are always accompanied by aversion and desire. The movement of concentration upon self and of the defensive, common to all personal or egotistical feelings, gives to their expression, as M. Mantegazza has remarked, a character essentially concentric or centripetal, while the expression of the benevolent affections is centrifugal and "eccentric." Fear presents the type of the concentric physiognomy pertaining to the affections which have for their center the *me*.

While the feelings derived from aversion are concentric, those derived from desire are expansive. The setting forth of them is expressed by the body, the arms, the head, lips, and eyes, by a tendency to enlargement and touch, the aspect of which is varied according to the nature of the objects and of the possible touch. With joy and suffering, aversion and desire, we have the four fundamental passions, the commingling of which is sufficient to account for all the others, and the expression of which in like manner engenders the most complex mimicry. Physiologists have not taken enough notice of the simplifications which could thus be effected by psychology. The whole can be definitely relegated to a general movement of the will toward the objects or their opposites; and it is the correlative movement of organic expansion or contraction that is the real generator of the language of the emotions.

We pass next to the considerations, ordinarily neglected, that can be borrowed from sociology. When the series of brain-disturbances is produced which have their origin in the appetite or the zest of life, the movement is then inevitably propagated to all the organs. There is in this case, in the first instance, a mechanical contagion, but there is, also, we think, a psychological contagion, and consequently a social phenomenon. The organism, in fact, is a compound of elementary organisms, a society of living cells, united among one another by bonds more or less strict. The cerebral cells being analogous to all the other cells, it is hardly probable that these should not also have their mental side—that is, that they should not be the seat of rudimentary sensations, of vague emotions, and of blind appetitions. In the myriapod it is the head or terminal segment that directs, sees, and smells, but all the other segments also fulfill their appropriate functions, and have their peculiar life in the midst of the collective life. If we cut the animal into several parts, the different parts will continue to move and react under external excitations; it is, therefore, improbable that the head should be the only part to possess sensibility and appetite. When a wound is inflicted upon the animal, it is felt in different degrees by all the segments, and the reaction is propagated from segment to segment. With the superior animals, which are a sort of very centralized states, the concentration of consciousness into the head only obscures the rudiment of sensibility which is still subsisting between the other parts.

For these reasons, we suppose a solidarity of the parts in the living body which, mechanical without, is mental and social within. Hence there can be no irritation of a part without its propagating itself by contagion to all the other parts; this is the germ of the diffused sensation which is felt in the whole body. Furthermore, this irritation being always either favorable or unfavorable to the life of the whole and of the parts, would be felt as rudimentary pain or pleasure—that is, as the germ of the diffused emotion. Finally, all the parts having power to react and a tendency to their own conservation, the irritation brings on a motive reaction of the whole body; this is the germ of the diffuse appetite, of the zest of life inherent in the whole. The solidarity, in the association of living cells, then takes the triple form of a solidarity of extension, of emotion, and of reaction. We could summarize this mutual communication of the organs with the words sympathy and synergy. We think we make a metaphor when we say, "I am suffering all over my body"; but we are only expressing the exact truth: when a part of the organism is suffering, all the other parts feel it by rebound, each according to its importance and its degree of organization. The cry of alarm that issues from the mouth is the translation to the ear of the alarm which is produced not in the brain only, but out to the smallest parts of the organism; it is the cry of an entire people which finds its life threatened. Expression is then a social phenomenon of sympathy and synergy, which is interior to the organism before extending to neighboring organisms.

Thus, we think, is explained the association of similar sensations with one another, and of sensations with emotions. Wundt has insisted upon these two psychological laws, while he has perhaps limited himself too much in establishing them. By virtue of the first law, analogous sensations are associated together; grave sounds have a relationship with somber colors; high tones with bright colors and with white. The sharp sound of the trumpet, and bright yellow and red, correspond. We say, with reason, that there are shrill colors, also that there are cold colors and warm. The reason of these existing affinities between different sensations is that they can be relegated to a fundamental unity; they are all, fundamentally, excitations and sympathetic reactions of the same primordial appetite.

This fundamental unity explains, we think, the other great psychological law of association, which connects the sensations with analogous emotions—a law which plays a very important part in expression. Wundt has shown that there is something exact in the images of vulgar language—a *hard* necessity, a *sweet* tenderness, *bitter* griefs, *black* cares, a *somber* destiny. These images, so far from being wholly artificial, have their natural origin in the constitution of our sensibility and in the relation of the sensitive organs to the motor muscles. Our sensitive organs are provided with muscles which have the double purpose of better disposing them to receive favorable excitations and removing harmful agents. The mouth takes a different form and expression accordingly as we are tasting a sweetened liquor or swallowing a bitter draught; in the former case, it seems to dispose itself to attract and receive, in the latter to repel and reject. Darkness, a glaring light, a clear daylight, give by turns a different figure to the physiognomy. By virtue of the association of the emotions with similar sensations and of these with their corporeal expression, agreeable or disagreeable feelings—joy, esteem, fear, grief, spite—are manifested by muscular contractions resembling either the action of pleasing tastes and smells, and of the luster of a tempered light, or of bitterness, poisonous odors, darkness, and blindness. If the expression is the same for the physical sensation and the moral feeling, it is because both have their unity, not only in the same field of consciousness, but also in the same movement of the appetite and the will. Whatever the causes and whatever the objects, we simply desire what augments our activity, and repel what diminishes it.

Reciprocally, the willful expression of an emotion which we do not feel, generates it by generating the sensations connected with it, which in their turn are associated with analogous emotions: the actor who expresses and simulates anger ends by feeling it to a certain extent. Absolute hypocrisy is an ideal; it is never complete with a man, realized in full, it would be a contradiction of the will with itself. In every case, Nature is ignorant of it; sincerity is the first law of Nature as it is the first law of morals. So it is with sympathy. Nature knows no isolation of ideal egoism; it brings together, it confounds, it unites. Like heat and light, it can not give life and sensibility to one point without making them radiate upon the other points. Even within the individual organism, it establishes a society; and he who believes himself one and solitary is already several: the *I* is already the *we*. In this way, all the organs, the heart, arteries, nerves, and muscles sympathize with the brain, and tell, each in its own language, of the suffering or enjoyment in which they are participating. In this way, too, the brain sympathizes with the organs, changes their pain into sadness, and their sensation into feeling ; it sends them back its pain and receives it multiplied ; a sad thought soon has a *cortége* of myriads of painful sensations, from the movements of the heart and chest to the most superficial parts of the organism.

To the association of analogous sensations or emotions may be referred, we think, the third of the laws of expression, which Darwin has studied without exhibiting its real meaning—the law of antithesis. Some states of mind, says Darwin, induce in the animal certain habitual acts which are useful to the support or defense of life ; and when a state of mind of a directly inverse character is produced, the animal instinctively and by antithesis performs the opposite acts, even when they are useless. Physiologists have rejected the Darwinian principle of antithesis, and the examples he cites in illustration of it may generally be explained in another way. But we think the principle has a psychological value which Darwin failed to elucidate. The association of states of consciousness takes place by contrast and antithesis as well as by analogy ; contraries as well as similars are subject to a law of association, which is especially manifested in the domain of the emotions. There exists a fundamental antithesis between pleasure and pain, between acceptation and repulsion by the will. An organic connection appears to be established between these opposites, in such a way as to produce a perpetual bifurcation of movements. It is not, therefore, strange that the contrary of a feeling should be expressed by contrary movements or attitudes, aside from all considerations of utility or all choice of the will. This contrast affords a means of facilitating the interpretation of signs.

The law of antithesis is thus a particular case of the law of association, which itself results from the natural concert of all the organs. This concert, or sociality, is so much the essential character of the emotion and its language, that the absence of accord and consonance between all the parts of the organism gives us the means of distinguishing feigned emotions from real. Thus, in theatrical pain, the expression is exaggerated out of all proportion to the occasion, and the real physical condition is so unlike the assumed that the sham is easily detected, and the illusion may be destroyed by a slight accident. On the other hand, when dissimulation of a real emotion is attempted, it is very hard to keep the current of feeling, which is not allowed to express itself in the natural way, from finding vent in some other way, as in mental excitement, or in movements which apparently have no relation to the suffering experienced. Passions on the point of breaking out may be revealed by rhythmical movements of the fingers, or by forced respiration.

Expressional movements, associated according to the laws we have reviewed, end by fixing themselves and leaving traces, not only in passing attitudes, but also in that permanent attitude which constitutes the form of the features. Persons leading the same life, as man and wife, sometimes ultimately acquire a similarity of physiognomy. Animals faithfully express the passions of their race in their organs and attitudes; and men, in turn, reproduce in themselves various types of animality. Different races of men have their own respective varieties of physiognomy, according to the predominant traits of their characters, and different nations among men of the same race.

The professions also leave their traces in the forms of the organs and in the features. "The bearing of the soldier," says M. Mantegazza, "is precise, stiff, and energetic; that of the priest, supple and unctuous. The soldier, even in civil life, shows in his movements the habit of obedience and command; while the priest in a lay dress wears the mark of the cassock and the cloth, and his fingers seem all the time to be blessing or absolving." So many other professions may be recognized by their attitudes, but there are limitations in the matter; for physiognomy, as M. Mantegazza says, "can not yet be considered an exact science, because we do not yet know all the elements of the problem. It has, nevertheless, its well-established general laws We are not likely to confound a frank physiognomy with a tricky one, or an honest face with the face of a debauchee or rascal."

There remain a few words to be said on the interpretation of signs, in which the old psychology saw a mysterious faculty. We regard it as the simple continuation in another of the sympathetic contagion, of the solidarity which is first manifested in the interior of an organism. In the exterior as well as in the interior of our body, sympathy is the only psychological law of expression; to interpret is to sympathize. In a mechanical view, this sympathy is a real communication of movements, as when the vibrations of a bell set another bell in vibration; in the psychological and social view, it is a real solidarity of sensations, impressions, and volitions. The instinctive reaction of the will under the influence of the feeling, having been extended by contagion to our whole organism, extends by contagion to similar organisms, and, if other men comprehend what we feel, it is because they themselves feel it. The final result of this sympathetic communication is the retranslation of the emotion felt by one into similar emotions in the others. The emotion of our neighbor is returned to us by a kind of response or return shock. Seeing the movements and attitudes of others, we tend to realize them in ourselves; then, as by a counter-stroke, the movement and attitude realized by us reproduce in us the feelings that correspond to them.

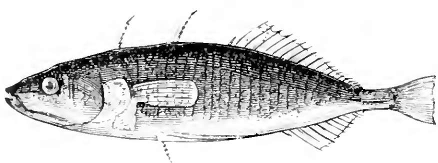
Mr. Spencer would explain the interpretation of signs by a purely mechanical association. This same cause, acting upon several animals simultaneously, makes them, for example, utter the same cry of alarm; the fear and the cry are finally associated mechanically; this association, by the survival of the best endowed, becomes organic and hereditary; at least the mere hearing of the sound of alarm will be enough mechanically to awaken the feeling. While we do not deny the influence of habit and heredity, we think that this explanation of Mr. Spencer's is still too exterior. There is an intimate connection, both physiological and psychological, between the cry of distress and the distress itself. The part of heredity and selection is simply to augment more and more the kind of internal sonorousness by which one being responds to the emotion of another. And why does this sonorousness become stronger as the being has more intelligence? Because, its power of representation having increased, it can represent to itself with more vivacity what other beings, and in due order itself, feel. But intellectual sympathies are less the true conditions of the affective life than organic sympathies. Intellectual sympathies present a kind of intermittent character; but the sympathies of the organs among one another never wholly cease till death; and from this results a constant necessity for sympathy with others which is the extension of the concert that was begun in our organism.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

## THE THEORY OF TITTLEBATS.

THE last theory of tittlebats of which I remember to have heard anything was that broached by Mr. Pickwick in connection with his profound and celebrated researches into the origin of the Hampstead Ponds. The suggestion of a causal connection between organism and environment, thus implied by the very title of Mr. Pickwick's paper, might lead one to suppose that the philosopher of the Fleet may have been really an early evolutionist, a Darwinian before Darwin, and an unconscious precursor of the now fashionable biologists, who account for everything on the Topsy principle of supposing that it "growed so." For undoubtedly the tittlebat was developed in, for, and by his native ponds, and any comprehensive theory of his existence and history must necessarily begin with the environment that produced him. Unfortunately, however, nothing now remains of Mr. Pickwick's valuable disquisition, except the bare title, enshrined among the posthumous papers of the club that bore his name; and I am therefore compelled, in reconstructing the theory of tittlebats on my own account, entirely to ignore the labors of my distinguished predecessor, and begin again *de novo* from the very outset.

The name itself of the tittlebat, I regret to say, appears in Mr. Pickwick's lost memoir in so debased and corrupt a form as scarcely to be recognizable to the philological student. His true title, I need hardly remark in this age of inquiry, ought to be stickleback; and he is so called in virtue of the stickles, spines, thorns, or prickles which represent and replace the first dorsal fin in all his kindred. But though the stickleback is so small a fish as even to have excited the scorn and ridicule of our great novelist, he can boast of almost as many *aliases* as the French counts and other sporting gentlemen who periodically return to journalistic fame under the ever-green heading of "The Great Turf Frauds." Besides his recognized literary English name of Stickleback, with its vulgar London variant Tittlebat, he is also diversely known to the ingenuous youth of this kingdom as the Banestickle, the Jack Bannel, the Harry Banning, the Sharpling, the Banticle, the Tanticle, the Hackle, the Sharpnails, the Stanstickle, the Tommy Parsy, the Prickleback, the Barmy, and the Tinker; all names implying at once a certain amount of affectionate regard on the part of his sponsors not uncombined with a due respect (the child of experience) for his remarkable offensive and defensive powers. A true theory of tittlebats would have to account not only for the peculiarities of bony structure which have secured the stickleback these his many names, but also for the oddities of domestic arrangement which I shall further unfold in the course of this article.

The common English stickleback, with whom I propose here chiefly to deal, is a fresh-water fish, much discovered in ponds and small rivers, and abundant everywhere in the neighborhood of London. Many famous anglers, as Frank Buckland used to observe, were first "entered" for the noble sport by fishing for stickleback in the Regent's Canal. The fishing is most frequently pursued in the following fashion: You take a stick with a piece of thread tied to it, and a short bit of worm fastened to the string by the middle without any hook or even a bent pin to represent one. When the stickleback, who is naturally a greedy feeder, approaches the worm, he quickly swallows it, and you pull him up with a jerk before he has had time effectually to disgorge his gulped-down mouthful. Expert anglers at this particular task have even been known to jerk up two sticklebacks at a time, each intent upon one end of the worm; but this is a fine point of science not to be imitated by the uninstructed tyro. The fish, when landed, are consigned to pickle-bottles filled with water, and are commonly sold to the proprietors of domestic aquariums for the small charge of a penny a dozen. In this way, a working acquaintance with the habits and manners and peculiarities of the stickleback has been generally diffused throughout a large portion of the unscientific British population.



Two-Spined Stickleback (*Gasterosteus biaculeatus.*)

Nevertheless, I hold it is a fatal error to suppose that the theory of tittlebats falls in any way below the dignity of a profound philosopher. On the contrary, there are points in the psychology and physiology of the common stickleback which merit the close and undivided attention of the most accomplished naturalist.

I will begin with one of the best-known habits of the stickleback, its nest-building instinct; because that is really the one of its peculiarities which most affects the theory of tittlebats, and has the deepest interest and the widest implications for the general reader.

If you put a pair of assorted sticklebacks into a small aquarium, and supply them well with food during the early spring, you will find that after a short time the male fish begins to undergo a remarkable change of personal appearance. His coloration grows brighter and more beautiful; his throat and belly assume a deep crimson hue; his eyes acquire a brilliant bluish-green metallic luster, like the gorget of a humming-bird; and in the well-chosen words of his panegyrist, Mr. Warington, his whole body becomes almost translucent, and seems to glow as with some mysterious internal brightness. It is the season of courtship, and the stickleback is adorning himself in his courting suit.

> "In the spring a ruddier crimson comes upon the robin's breast,
> In the spring the wanton lapwing gets himself another crest,
> In the spring a livelier iris changes on the burnished dove,
> In the spring a young man's fancy lightly turns to thoughts of love."

The name of the stickleback falls unfortunately below the level of the lyrical muse, or else he might perhaps form a fifth member in that lovers' quartet. For no creature decks himself out in more gorgeous nuptial colors, or arrays himself more like Solomon in all his glory against his wedding-day, than the common little Hampstead tittlebat of Mr. Pickwick's missing dissertation.

Theoretically, of course (and we are all on the theory of tittlebats here), this assumption by the stickleback of special colors and ornaments for the pairing-season is all of a piece with the numerous other devices of Nature for securing the due selection by animals of the handsomest, strongest, and most vigorous mates. Many of the more brilliant animals don their finest decorations for the period of courtship only. The crests and lappets of the herons and egrets are developed and retained during the summer alone; they fall off as soon as winter arrives. The African widow-birds deck themselves out in the nesting-season with very long and conspicuous plumes, which disappear again, and leave them as mere inconspicuous little brown birds, after the brood is reared. The crested newt puts on his vandyked head-gear, and dapples his body with orange and crimson spots, at the approach of spring-tide. The speckled trout becomes livelier in hue; the salmon shine with brighter silver; the lizards acquire their metallic throat-pouches. It is at such times alone that the face of the mandrill glows with blue and purple, or that the rhesus monkey blushes a vivid crimson. Throughout the whole of nature, in fact, all the most beautiful animals attain their highest beauty in the season of courtship, and many which are never beautiful at other times then put on the most decorative ornaments or the most gorgeous coloring. This is true alike of the wings of butterflies, and of the song of crickets;

it is true of the gemmeous dragonet and of the butterfly gurnard, of the peacock and the humming-bird, of the bird-of-paradise and the argus pheasant, of the perfume of the musk-deer and the antlers of the stag, of the lion's mane and the monkeys' beards, crests, and gorgets. All alike are assumed for the self-same purpose, and all are useful merely to charm the fickle senses of the proverbially coyer and more uncertain sex.

The stickleback has acquired his gorgeous wedding-garb, in accordance with a general law of animal life, in order to please and attract to himself the attention of his æsthetic and fastidious mates. "After the breeding-season," says Mr. Darwin, "these colors all change, the throat and belly become of a paler red, the back more green, and the glowing tints subside." Moreover, as usually happens in the case of all highly decorated animals, your stickleback further resembles Solomon in being a most undisguised polygamist in the natural state; and his brilliant hues have, no doubt, been developed to charm and draw to his side as many as possible of the female fish. Polygamous animals, in other words, are always handsome, because only the handsomest succeed in attracting to themselves a harem, and so handing on their peculiarities to future generations. Furthermore, the sticklebacks are all great fighters; and it may be broadly laid down once more as a general principle of animal life, and at the same time a contribution to the theory of tittlebats, that all very handsome and decorated creatures are naturally pugnacious of disposition. Thus stags fight one another with their branching antlers for the possession of the does. Salmon constantly join battle and tear one another to pieces savagely on the recognized spawning-beds. The polygamous ruff, distinguished from his sober-suited mate the reeve by his curious crest, and by the great collar of plumes from which his name is taken, is as full of the Homeric joy of battle as a game-cock, and quite as gamy. The wild Sumatran ancestor of our own barn-door fowl "does battle in defense of his seraglio till one of the combatants drops down dead." Black-cock and capercailzie assemble annually at regular tournaments, to fight one another, and display their beauty before their expectant and undecided dames; and on such occasions Kovalevsky has seen the snow of their arenas in Russia all red with blood, and covered with the torn-out feathers of the champions. Most of the handsomest birds and animals, indeed, are provided with special weapons for these fierce encounters, such as the spurs of game-birds, the horns of antelopes, the antlers of stags, the tusks of the musk-deer, the wing-darts of the palamedia, and the fierce spiny fins of the most decorative fishes. Even the dainty little humming-birds themselves are prodigious fighters, and I have seen them engaging one another in their aërial battles with the utmost pluck, vigor, and endurance. Furthermore, beauty in animals is almost always accompanied, as Dr. Günther has observed, by a very hasty and irritable temper.

And now, I think, we are beginning to get a little nearer toward the theory of tittlebats. For the male stickleback is a prodigious warrior, and, when he meets a rival of his own kind, he engages with him at once in deadly warfare. Their battles, says Mr. Darwin, are at times desperate, for these puny combatants fasten tight on each other for several seconds, tumbling over and over again, until their strength appears utterly exhausted. Bold and pugnacious as they are, however, it is only my lords who thus fiercely contend with one another; their demure little mates remain always perfectly pacific, gentle, and even-tempered. With the rough-tailed stickleback, the males while fighting swim round and round one another, biting and endeavoring to pierce each other's mailed skin with their raised lateral spines or lances. Small as they are, their bite is very severe, and inflicts a deadly wound upon their antagonist; and Mr. Noel Humphreys remarks that they use their lateral spines with fierce effect, so that he has seen one brave stickleback during a stout battle rip up his opponent from end to end, till the vanquished hero sank to the bottom and died ingloriously.

It is during the moment of battle, and just before and after it, that the colors of all fighting animals become invariably most intense. The reason is plain: battle is joined during the mating-season, and "before the face of maidens and of dames"; and, as in human tournaments, the ladies stand by to applaud the conquerors and to reward their prowess. They are themselves the prize of the encounter they stimulate. Besides, the highest physical vigor and the highest excitement bring out the greatest beauty both of men and animals. The angrier you make a mandrill, the more vividly tinted are his cheeks and callosities. The frilled lizards and flying-dragons glow with all the brightest colors of the rainbow when you tease or annoy them. The turkey-cock swells his crimson wattles and spreads his ruffled feathers to the utmost at sight of a rival or a mischievous boy. There is a little hot-tempered fish known as *Betta pugnax*, and kept as a sort of domestic pet by the Siamese (much as the Christian English gentleman of forty or fifty years since kept fighting-cocks) to display its prowess for the edification of the Mongolian intelligence. "When in a state of quiet," says Cantor, "its dull colors present nothing remarkable; but if two be brought together, or if one sees its own image in a looking-glass, the little creature becomes suddenly excited, the raised fins and the whole body shine with metallic colors of dazzling beauty, while the projected gill-membrane, waving like a black frill round the throat, adds something of grotesqueness to the general appearance. In this state, it makes repeated darts at its real or reflected antagonist. But both, when taken out of each other's sight, instantly become quiet." The fighting-fishes, as the Siamese call them, are kept in globes like gold-fish, and fed from time to time with the larvæ of mosquitoes. The Siamese are as wild after their combats as the Malays are for cock-fighting, and often stake large sums, or even the freedom of themselves and their families, on the prowess and skill of a particular betta. The license to exhibit fish-fights is farmed by Government, and brings in a considerable revenue to the King of Siam.

Now, much the same thing happens on a lesser scale during the battles of the sticklebacks with their pugnacious rivals. It is then especially that their bodies assume the beautiful transparent and iridescent colors so poetically described by Mr. Warington. Their vitality rises to its highest point, and their eyes sparkle like a girl's at a ball with the most vivacious brilliancy. But when a hapless stickleback is conquered in the lists, says Mr. Darwin, "his gallant bearing at once forsakes him; his gay colors fade away; and he hides his disgrace among his peaceable companions, but is for some time the constant object of his conqueror's persecution."

It is pretty clear, then, that the stickles and lateral spines of the stickleback have been mainly developed, like the spurs and wing-weapons of birds, the tusks of boars, the antlers of deer, and the horns of lizards, for the purpose of combating rivals in these annual contests, and of securing the favor of the female fish. The same thing is also true of their beautiful colors, or rather, both are but different sides of the same question; for, as Mr. Wallace has shown, the most beautiful animal is also the strongest and most efficient, and the periods of high vitality are always accompanied by the most ornamental developments and the most vivid coloring. From generation to generation, the strongest, best armed, and most brilliant sticklebacks have conquered the feebler or uglier in battle, and have been selected as husbands by the greater number of their fastidious mates. None but the brave deserve the fair; and, among sticklebacks, none but the brave succeed in winning them. I do not doubt that the stickles also prove incidentally useful to the fish in protecting him from the attacks of larger predatory species; sticklebacks are seldom attacked by perch or trout, and an instance is on record where a pike has been choked by one of these tiny creatures, which erected its sharp spines in his throat as the greedy monster tried to swallow it; but this secondary purpose is only a derivative one; the spines themselves must originally have been developed, as in all other cases, for the wedding tournaments between stickleback and stickleback. It is thus that the horns and tusks of higher animals primarily produced in the internecine combats of the males are occasionally employed for external defense; thus that the spurs and beaks of birds are occasionally turned to the protection of their fledglings. But it may be laid down as a general law of biology, in spite of misconceptions and misstatements to the contrary, that no animal habitually and normally fights any other creatures except individuals of its own species. Dog fights dog, and tiger tiger; but game-cocks do not engage with turkeys, nor do stags usually join battle with buffaloes or bears.

As soon as the pairing-season sets in, the first care of the male stickleback is to provide a nest for his wife and children. For the stickleback is just as much a nest-builder as any bird; only, he does all the work himself, instead of being aided, as birds usually are, in

STICKLEBACKS AND THEIR NESTS (*Gasterosteus aculeatus*).

the task of nidification, by his attentive partner. He begins by busily collecting a quantity of delicate fibrous material, the tissues of water-weeds or of macerated land-plants, which he mats with his mouth into an irregular circular mass, somewhat depressed, and about an inch and a quarter in diameter. Then he covers the top with similar materials, and leaves in the center of one side a large, round aperture to act as a doorway. As he mats the fibers together by creeping over them with his body, he cements them firmly with the slimy mucus that exudes from his skin. He is a quick worker, not to say a jerry builder (any one can watch the whole process easily for himself in a fresh-water aquarium), and he only takes a few hours in getting the entire residence completed from basement to coping-stone. As soon as it is finished, the little architect sets out on his quest of a partner or partners ready to occupy it. If he meets a rival on the way, the two small Turks fight out their differences at once on the spot, while the bride-elect amicably stands by expectant, and accepts the conqueror. When she emerges from her hiding-place under the waving weeds and comes out, the guerdon of his prowess, to survey the nest he has deftly woven for her, the tiny sultan positively dances and curvets around her, "mad with delight," as an acute observer has well worded it. "He darts round her in every direction; then to his accumulated materials for the nest; then back again in an instant, and, as she does not advance, he endeavors to push her with his snout, and then tries to pull her by the tail and side-spine to the nest." Indeed, there is a deal more that is human and natural in the lives of all these little despised creatures than the people who laugh at theories of tittlebats have ever stooped to notice or discover.

As soon as the stickleback has duly inducted the partner of his choice with many caresses into the home he has built for her, or rather for her offspring, he introduces her by the door he has left in the side into the closed chamber. In a few minutes the bride has laid two or three tiny, transparent yellow eggs, after which she bores a hole with her snout on the side of the nest opposite to that by which she entered, and makes her exit, a divorced wife, without further formalities. "The nest," says Dr. Günther, "has now two doors, and the eggs are exposed to the cool stream of water, which entering by one door flows out at the other." This, of course, by keeping up a fresh and constant current, supplies them with the oxygen necessary for hatching. Next day, the little sultan goes out again in quest of a fresh mate, and brings back his new bride to add a few more eggs to his stock of spawn. This operation he repeats daily until the nest is nearly full; and then the fond father sets to work himself at the congenial task of incubation. For among fish it is almost always the male, not the female, who sits upon the eggs and charges himself with the care and education of the young fry.

For the subsequent stages, I can not do better than quote Frank Buckland's animated account of a case observed by the learned curator of the Norwich Museum. "Nothing," says the genial naturalist and angler, "could exceed the attention from this time evinced by the male fish. He kept constant watch over the nest, every now and then shaking up the materials and dragging out the eggs, and then pushing them into their receptacles again and tucking them up with his snout, arranging the whole to his mind, and again and again adjusting it until he was satisfied; after which he hung or hovered over the surface of the nest, his head close to the orifice, the body inclined upward at an angle of about 45°, fanning it with the pectoral fins, aided by a side motion of the tail. This curious manœuvre was apparently for the purpose of ventilating the spawn; at least by this means a current of water was made to set in toward the nest, as was evident by the agitation of particles of matter attached to it. This fanning, or ventilation, was frequently repeated every day till the young were hatched; and sometimes the little fellow would dive head foremost into his nursery and bring out a mouthful of sand, which he would carry to some distance and discharge with a puff. At the end of a month the young ones were first perceived. The nest was built on the 23d of April; the young appeared on the 21st of May."

After the young are actually hatched, the fond parent only redoubles his delicate attentions. He never leaves the precincts of home by day or night; and he guards the nest with the utmost pertinacity, allowing no stray intruder from any side to approach it. If a greedy water-beetle or other enemy comes near the young, this exemplary father runs full tilt at him with his armed spines, pounces upon him broadside, and unceremoniously shoves or tumbles him over. If you try to disturb him in an aquarium with a stick or pencil, he will charge at it smartly, and strike it so hard that the blow can be distinctly felt by the hand that holds it. Among the enemies he has to repel on such occasions, I regret to say (for the honor of maternity I would fain conceal the fact), are the mothers themselves of his little charges, who wish to emulate Saturn and the common rabbit by making a dinner off their own flesh and blood. "For a whole month," says Dr. Günther, "he watches over his treasure, defending it stoutly against all invaders, and especially against his own wives, who have a great desire to get at the eggs." Those unnatural parents, indeed, make such a dead set upon their young and the devoted father who guards them, that, as Mr. Darwin cynically observes, "it would be no small relief to him if after depositing their eggs they were immediately devoured by some enemy, for he is forced incessantly to drive them from the nest." Let us trust that the wedded stickleback himself never indulges in such uxoricidal fancies.

The fry, when hatched, are at first so very minute and transparent that you can with difficulty perceive them in the water of an aquarium, and even so only by the gentle fluttering motion of their wee fins. Their good papa continues, however, to perform the duties of a nurse for them with profound vigilance, confining them at first to the meshes of the nest, and, when they stray too far, gently leading them back with unremitting kindness to the path of duty. By degrees, as their knowledge of the world increases, he wisely allows them to indulge in greater excursions, and hollows out for them a small basin in the sand of the bottom, where they may disport themselves at their ease until they grow strong enough to venture on a wider range of thought and action. If rival papas or hungry mammas attempt to devour them, he falls upon the assailants in a violent fury, and carried away, it would appear, by the warmth of his feelings, occasionally goes so far as actually to indulge in acts of cannibalism. For this I do not commend him. No amount of ethical enthusiasm can ever justify a truly moral being in devouring the persons of his fallen enemies.

Fellows of the Royal Geographical Society are probably aware that in the neighborhood of London, and more precisely through the parish of Wandsworth, there flows a minor tributary of Thames, by name the Wandle. This stream, as the sportive youth of South London know full well, abounds in sticklebacks of all ages and sexes; and here it was that Mr. Smee, one of the chief contributors to the modern theory of tittlebats, first observed their habits and manners. "They are very pugnacious and cunning creatures," says he, in his charming work, "My Garden." "They build a nest and protect it. In the middle of May I observed a stickleback evidently guarding a circle of about two inches in diameter, and chasing away every other fish which came within his domain. On closer examination, I saw at the bottom a small circular plate of the same size, made of fiber, but arranged level with the bed of the stream. Suspecting a nest, I carefully raised it, when it proved to contain two parcels of eggs, which were about the size of a large pin's head. I immediately replaced the material as well as I could in its former place; but the stickleback was not at all satisfied with my arrangement, and set to work diligently to adjust it himself. He brought little bits of fiber and thrust them into the mass, and rearranged the larger fibers. When he was perfectly satisfied with what he had done, he mounted guard and rushed at any other fish which came near him. Afterward, I found these nests by scores, each protected by its guardian stickleback; and in the month of May I can always delight my visitors by showing them a nest presided over by the pugnacious little fish." I may add that similar nests are to be found in almost every brook or pond in England at the appropriate season: only, you must be born with the proper eye for seeing them. It is not every man who can discern stickleback. I once conducted a statistical survey of all the lizards inhabiting Great Britain and Ireland, and came to the conclusion, as the result of my census, that the lacertine population of the United Kingdom numbers at least two hundred million, or more than five times the human beings; and yet how often most people on their walks abroad meet a man, and how very, very seldom they happen upon a lizard!

Sticklebacks are not by any means the only fish which thus take care of their helpless progeny during the first weeks of infancy. It must be remembered that our acquaintance with the domestic habits and manners of fishes, and especially of the marine species, is but sporadic and fragmentary; opportunities for observation are rare on the sea-bottom, while, as for aquariums, the life there is so strained and unnatural that we learn for the most part little more from that source than one would learn of the intricacies of human existence by watching the interiors of prisons and of convents. But even among the few fish at all intimately known to us at present, there are several which deserve high commendation for their able and conscientious discharge of their paternal duties. Certain cat-fish, for example, and many other species, construct nests like good fathers, and guard the spawn deposited in them by their unnatural spouses. One siluroid bearing the suggestive classical name of Arius actually carries the eggs about with him in his own mouth, and there devotedly hatches them. There is a fish of the Sea of Galilee, locally supposed to be the very kind from whose mouth St. Peter took the miraculous denarius for the payment of the apostles' tribute, and this pious and well-principled creature (even his scientific name is *Chromis sacra*) holds his eggs in the same fashion, and hatches them out in his capacious pharynx. Among the pipe-fish and sea-horses, including the well-known hippocampus of the Mediterranean and the Westminster Aquarium, Nature has gone one step further in the direction of parental supervision. These fish have a regular pouch like the kangaroo, in which the excellent papa retains the young till they are of full age to shift for themselves.

Yet even here it is the fond father, not the gay and careless mother, who wheels about the family perambulator: only two known cases occur among fish where the mother takes any part at all in the hatching or education of her own young. One is a cat-fish from British Guiana, whose under surface becomes soft and spongy after the spawning-season. The mother, as soon as she has laid her eggs, presses them hard into this spongy integument by lying on top of them. There they stick, and she carries them about in the pits thus formed, much as the familiar Surinam toad carries about her hatching ova and tadpoles in the skin of her back. The other instance is that of a singular pipe-fish from the Indian Ocean, who forms a pouch for her young by allowing her ventral fins to coalesce with the soft skin of her under surface. These two examples of devoted maternity, however, scarcely suffice to absolve the mother-fish as a class from the general charge of heartless desertion brought against them by modern ichthyologists.

It is worth while, perhaps, to note in passing (since a theory of tittlebats is nothing if not exhaustive) that the eggs of stickleback are larger in proportion to the size of the full-grown individual than those of any other known fish. Why is this? Simply because the stickleback are good fathers, who take great care of their callow young. (I don't know what callow means, as applied to a fish, but I feel sure it is a neat and appropriate epithet.) Where the chances of infant mortality rule high, the mother-animal must produce vast numbers of small and ill-supplied eggs in order to provide against the adverse possibilities. That careless parent, the cod, who lays her spawn unprotected upon the shallow banks, for thousands of greedy enemies to devour, often produces at a single birth as many as from four to nine million separate eggs. But just in proportion as the eggs and young are more efficiently guarded and provided for in life does it become possible to economize in the number of germs originally produced, and to give each at the outset a fair supply of yolk to start well in life with. Compare the myriad tiny black seeds of the poppy, which take their even chances anywhere that fate may carry them, with the richly stored bean or pea or filbert, well provided with nutriment for the growing seedling, and you will see at once the force of the analogy here intended. The codfish lays a great many ill-supplied eggs, and lets them shift for themselves in the open sea as best they may, on the off chance of one among four million or so reaching maturity ; the stickleback lays comparatively few large and well-supplied eggs, but the amiable father watches with tender solicitude over the safety of all, so that on an average two at least out of each mother's small brood must needs survive to years of adult sticklebackhood.

I have spoken of the stickleback genus so far as though, like the French Republic, it were one and indivisible. Such, however, is not the case. The family has split up into several minor sections, each adapted to particular situations. There are some ten known species of stickleback, and the facts hitherto noted apply most especially (save in a few instances) to one above all others among them, the common British three-spined stickleback. All the varieties are pretty much alike in all essential points, having the same long, flat-sided bodies, with hard cheeks, while parts of the skeleton usually form an external coat of mail, and grow out into large scutes or shields along the sides. On their back are more or fewer of the spines from which the entire group take their generic name, nine in one species, fifteen in another, three only in the commonest English form, and no more than two in the pretty little North American example. One of them has adapted itself to brackish water and the open sea ; the others are all fresh-water forms, though most of them at a pinch can manage a sea-voyage without serious damage to their constitutions. They are a north temperate family by origin ; in other words, they have sprung up in the rivers of the sub-Arctic zone, and have not yet spread beyond the Arctic and temperate regions of the northern hemisphere on both sides of the Atlantic.

Our common little British river stickleback, the familiar tittlebat of the Serpentine and the Hampstead Ponds, is the three-spined form (*Gastrosteus aculeatus*) ; and he has generally, in addition to his offensive spines, a series of defensive shields or plates along the gleaming side of the body. In Central Europe, however, these shields generally disappear, I suppose through the absence of some dangerous enemy to whose attacks the little creature is habitually subject in our British waters. This last idea, however, must be accepted as purely theoretical, for I can not suggest who that enemy may be. The three-spined stickleback is a very active and voracious little fellow, exceedingly destructive to the fry of carp or trout, and therefore, of course, highly detrimental in ponds where the preservation of larger fish is a matter of interest. It is scarcely to be conceived, says our great piscicultural authority, Dr. Günther, what damage these little creatures do, or how prejudicial they are to the increase of all the other fishes among whom they live. Their industry, sagacity, greediness, and success in seeking out and destroying all the young fry that come in their way are indeed simply marvelous. To take a single instance, a small three-spined stickleback kept in an aquarium devoured in five hours' time, by actual observation, seventy-four young dace, each a quarter of an inch long. Two days after, the same unconscionable little gourmand swallowed sixty-two, and seemed as hungry at the end of that bout as if he had never tasted breakfast. Considering that stickleback sometimes simply swarm in rivers, ascending them *facto agmine* in amazing shoals, the damage they are calculated to do to the trout and bream fishery can only be adequately known to Professor Huxley, who has long and truly urged that the number of fish caught or destroyed by man's will sinks into what the French scientists call *une quantité négligeable* by the side of the havoc everywhere wrought through the natural enemies of each species.

Our other native British fresh-water kinds are the nine-spined stickleback (commonly called the ten-spined out of pure cussedness) and the four-spined, also known as the smooth-tailed, though authorities differ much as to the division of species, some making many and some few. The nine-spined variety is a very small kind, more or less estuarine and semi-marine in his tastes, a frequenter of the river-banks about Southend and Chatham, and much given to migrating in shoals up the creeks and backwaters in early spring. He can also generally be discovered at the Ship or the Trafalgar during the fish-dinner season, trying to pass himself off in good company as a distinguished fish among a plateful of whitebait; but his imposture may be easily detected by observing the tiny stickles on his back, which are too small, indeed, to make him unpleasant eating, but quite big enough to prevent him from giving himself any aristocratic airs on the strength of his resemblance to a parliamentary delicacy. His sides are perfectly smooth and unprotected, and he may be investigated by the curious, nest and all, nearly everywhere among the brackish marshes of the Thames estuary.

The fifteen-spined stickleback or sea-adder is our one marine English species, common on many parts of the British coast, and specially observed by competent naturalists in Cornwall and the Orkneys. This salt-water descendant of the little river tittlebat grows, as might naturally be expected, to a larger size in his more spacious environment, and reaches the dimensions of an average trout. He never ascends rivers, even to spawn, but weaves his nest of sea-weed or corralline under some overhanging ledge, and guards his bright, amber-colored eggs with the same jealous care as his fresh-water relations. His personal appearance is chiefly remarkable for the very elongated form which procures him the name of adder, as well as for the prolonged snout, not unlike a gar-fish, and the rows of shields that protect his side with a perfect coat of sheeny sheet-armor. That admirable observer, Mr. Richard Couch, of Mevagissey, to whom, with Mr. Jonathan Couch, we owe most of our knowledge of marine fish-life, was the first to watch his manner of nesting. He found that the marine stickleback built its home in shallow water, where the bottom was thickly covered with sea-wrack, and that it bound the materials together with an elastic thread, resembling silk, which hardens by exposure to water, but the mode of whose secretion has not yet been determined. Mr. Couch visited one of the nests every day for three weeks, and saw the parent stickleback invariably mounting guard over it with military precision. When he ventured to disturb part of the materials, the fish immediately set about repairing the damage, by drawing together the sides of the opening, so as to conceal once more the eggs which the too curious naturalist had exposed to view. Stickleback will tolerate no eaves-dropping intrusion into the sacred privacy of domestic life. Society journalism is quite unknown among them.

These few remarks complete in outline the theory of tittlebats which I venture tentatively to suggest in substitution for Mr. Pickwick's lost and lamented essay. As its moral may not be immediately apparent to the young, the gay, the giddy, and the thoughtless, I shall not hesitate to append one in the undisguised form borrowed by modern ethical writers from Æsop's fables. If any of my didactic reflections scattered through the text shall have induced only one serious stickleback to abandon polygamy or to renounce cannibalism, I shall feel that this article has not been written in vain.—*Cornhill Magazine.*

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Professor T. B. Stowell advocates the study of natural history in secondary schools because of the adaptability of the subject to insure accuracy in perception, the use of a technical and exact vocabulary, ability to weigh evidence, and the power to classify and generalize. The field is so large and grows so fast that the experienced teacher finds his most difficult task in deciding what not to teach. As in all other branches teachers are supposed to have had some special preparation, so the same qualifications should be required in the teacher of natural history as in the teacher of language, and a corresponding proportion of time should be given to science studies. "With such instruction," says the author, "he will let results establish the claims of natural history in the curriculum of secondary schools."

## SKETCH OF KARL WILHELM SCHEELE.

THE life of Scheele affords a most conspicuous example in the history of science of a worker who has accomplished great things with the most limited resources. "We stand astonished," said Professor Clève, in his oration at the celebration of the one-hundredth anniversary of the chemist's death—from which we have derived most of the materials for this sketch—"that a man who only reached his forty-third year should have been able, during his short life, always tormented by material wants, to have arrived, by means restricted and inconvenient, at results which have had so mighty an influence on chemistry." Dumas, comparing him with Lavoisier and Priestley, has said of him that "brought up in a pharmacy, poor and modest, unknown to every one, and hardly knowing himself, inferior to the former but superior to the latter, vanquishing Nature by the force of patience and genius, he snatched her secrets from her and assured an eternal fame for himself."

KARL WILHELM SCHEELE was descended from an old family of German origin, and was born at Stralsund, Sweden, December 9 or 19 (authorities differ), 1742. He gave no particular promise in childhood, but was considered "slow," and only moderately intelligent. He took no part in the sports of his brothers and sisters, but amused himself with making all sorts of little objects, and would appear greatly pleased when any of his devices proved successful. His instruction began early at home, and he was at a later period given the usual course at the gymnasium in Stralsund. He became interested in pharmacy through the influence of two friends of the family; and, when fourteen years of age, he was entered as an apprentice with Bauch, a pharmacist of Gothenburg, where he soon found himself at home. A friend suggested to him to study chemistry, and his real vocation was revealed to him by the reading of the works of Neumann. From these he advanced to the works of Lémery, of Stahl, the author of the theory of phlogiston, and of Kunkel, the discoverer of phosphorus. He used to repeat secretly at night the experiments he read about in these books, and thus accustomed himself early to do the works of the masters over again with the most scanty and imperfect materials.

After six years of apprenticeship and two years longer of residence in Gothenburg, Scheele became engaged at Malmö, with the pharmacist Kjellström, who, having himself a taste for experimental chemistry, could sympathize with him. He spent his spare money in buying books upon this science; and it was during his residence here that he made the researches on the *Sal acetosellæ* that led up to the discovery of oxalic acid. He sent a memoir on this subject to the Academy of Sciences at Stockholm, which Bergman, to whom he intrusted it, withheld, because, he said, it contained nothing new.

In 1768 he obtained a place in a pharmacy at Stockholm, where he was not allowed any part in laboratory-work. He would make experiments, nevertheless, and so he studied from the windows of the shop the effects of sunlight upon different bodies. He made himself known, too, at Stockholm as a skillful chemist, and formed friendships with the distinguished scientific men of the time. In 1770 he removed to Upsala, where he was installed director of the laboratory-work in a pharmacy, with permission to continue his own experiments.

Forbern Bergman was then Professor of Chemistry in the University of Upsala, and the two men were soon brought into association. Scheele's master had remarked that, on exposing melted saltpeter to a continuous heat, a salt is developed which, on adding acetic acid, gives out red vapors. Neither the chemist Bergman nor the mineralogist Gahn could explain the phenomenon. Scheele had an explanation. He said that the heated saltpeter absorbed phlogiston (is reduced, as we would have it), and gave the salt of a new acid (nitrous acid), which is weak, and can be expelled by acetic acid. Gahn told Bergman of this explanation, and he sought an introduction to the young pharmacist. Thus was laid the foundation of a lasting friendship and co-operation between the two.

In 1775 Scheele obtained the direction of the pharmacy of Köping, whose proprietor had just died, leaving the concern to his widow. This gave him a more comfortable subsistence than he had enjoyed before, although his task in keeping the establishment in good condition and paying up its debts was hard enough. Yet he wrote to one of his friends at about this time: "You may think, perhaps, that material cares are going to absorb me, and take me away from experimental chemistry. Not at all! That noble science is my ideal. Be patient, and you will soon have something new to learn." He was much annoyed about six months afterward by some one coming to buy the pharmacy, and offers of other positions came to him from every side, among them an offer of the superintendency of a distillery, and invitations to Stockholm, Berlin, and London, with salaries that would have been tempting to common men. But the people of Köping said that they would have no pharmacist but Scheele; and he declined all the invitations, saying: "I can not do more than eat my meat; if I can do that at Köping, I need not seek it elsewhere"; and, in reference to an offer which had been made to him from Berlin: "After mature reflection, I decline it. I lack considerably of being as far advanced in chemistry as such a position requires, and I am persuaded that I shall find my daily bread even at Köping."

During his residence at Köping he only gave himself a single vacation, when he went to Stockholm to attend a meeting of the Swedish Academy of Sciences, of which he had been elected a member in 1775. It was the only meeting of the Academy he ever attended, although nearly all of his papers were published in its proceedings.

Bergman presided on that day, and received Scheele in the name of the Academy, addressing him in terms of warm eulogy. It was on this occasion that Scheele read his paper on the preparation of calomel. He had just passed his examination as a pharmacist, and received an authorization, free of charge in consideration of his services, to keep the shop at Köping. Bergman, in the same year, secured for him a pension of one hundred riksdalers to encourage and assist his investigations in chemistry, which was continued till his death.

Scheele had now before him the prospect of an easier future. But, although he had never before been ill, he had an attack of gout toward the end of 1775. He nevertheless continued his studies. In February, 1786, he sent to the Academy of Sciences his memoir on gallic acid. In the same month he was attacked with phthisis; and this disease ended with his death on the 21st of May of that year, two days after he had married the widow of his predecessor in the pharmacy.

Scheele was a man of medium stature and vigorous constitution, and was as modest as he was deservedly famous. Thus he wrote to a friend on the occasion of his being elected to the Academy of Turin: "I really believe they think that I am one of the greatest chemists of the time, and they might make me proud. If they keep on in this way, I might come to think I had as much experience and genius as Macquer and Bergman. But I believe, in truth, that those worthy men have more knowledge in their fingers than I have in my head." His education was not extensive, but he had been accustomed from his youth to think independently and without prejudice, and to verify his conclusions, and never to believe any assertion in chemistry till he had personally tested its validity.

There were no grand, elaborately furnished laboratories in those days, and nearly all the great chemists who did so much to put the science on a firm foundation began their work in pharmacists' shops. Scheele's apparatus was of the most simple character, and included a few retorts, common bottles and flasks, and, for experiments on gases, bladders. To collect a gas, he fastened the bladder tightly to the neck of the retort, in which the chemicals for the development of the gas had been placed. If he had to deal with such a gas as nitrous oxide, he saw that the interior of the bladder was well imbued with oil. He usually employed wooden tubes instead of glass ones, lining their interior with a goose-quill. It would be discouraging to a young chemist of to-day to be limited to such apparatus; but Scheele made up for what was wanting in his tools by his remarkable faculty of observation, perseverance, and keenness of discernment. In his experiments he observed all of the slightest details, and went so near to the bottom of things that he left very little for others to discover in any of the work that he did.

Scheele's scientific labors were performed in different fields of chemistry—general, inorganic, organic, and physiological. The "Treatise on Air and Fire" was written in 1775, and published in German in 1777; was translated into English in 1780, and into French in 1781. It contained many facts of great value, together with theories on the nature of combustion, fire, light, and heat, which can have now only historical importance. His researches on the subject, although they were parallel with those of Priestley, and although Priestley anticipated him in the discovery of oxygen, were conducted without any knowledge of what the English chemist was doing. Scheele showed in his treatise, from numerous simple and ingenious experiments, that air is composed of two gases, in a proportion, as he calculated, of about three to one; and he described the special properties of oxygen and nitrogen, as we know them, with their effects on combustion and on animal and plant life.

From experiments with "black magnesia," or the binoxide of manganese and saltpeter, now familiar to all students, Scheele deduced the theory that heat was a combination of phlogiston and oxygen, while combustion was the combination of the oxygen of the air with the phlogiston of the combustible body, resulting in the formation of the compound above named, or heat. Light was also a combination of oxygen and phlogiston, but richer in phlogiston than heat. The different kinds of light were different combinations of oxygen and phlogiston—an assertion which was based upon the fact that violet light exercises a stronger decomposing influence on the chloride of silver than does light of the other colors. Thus Scheele was the discoverer of the fact which is the basis of photography. He found that fluor-spar became phosphorescent when heated moderately, but not when heated to incandescence. This was because the mineral contains phlogiston, which, under a moderate heating, unites with the heat and forms light; but when heat is applied to the degree of incandescence, the phlogiston is all taken away and light can not be formed.

Hydrogen, or inflammable air, as it was then called, he regarded as composed of phlogiston and heat. But after Lavoisier, Cavendish, and Priestley had shown that water is produced by the combustion of hydrogen, and hydrogen is formed by passing the vapor of water over incandescent iron, Scheele changed his theory of oxygen, and assumed that it was composed of a *saline principle* of water and phlogiston; of these components, the former gave heat with phlogiston, and water caused an increase in the weight of the burned body. These theories attracted much attention at the time; but they are no part of science, for they were quickly dispelled by the publication of Lavoisier's more correct views on combustion. But the facts which Scheele sought to explain by them—nearly all his own discoveries—remain, valuable gifts to chemistry.

His experiments with fluor-spar, carried on in the course of his investigations on light, led to the discovery of hydrofluoric acid, and its property of acting on glass. In the course of three years' researches on *black magnesia*, or the binoxide of manganese, which M. Clève suggests may have been the most important that he made, he discovered that the basis of the mineral was a new fundamental body, manganese; that it contained, as an impurity, a new earth, baryta, and that when it was treated with muriatic acid another new substance was evolved, chlorine. Further experiments with the last substance revealed its bleaching qualities, which have been so extensively applied in the arts. Finding that the presence of white arsenic helped the solution of the oxide of manganese in acids, he experimented with that body, and discovered the more important arsenical compounds. Scheele discovered that phosphorus was the cause of cold-shortness in iron, and showed that argillaceous earth was distinct from silicious earth, and not an acid-worked modification of it, as had been supposed. He experimented with plumbago, and found that it was "a kind of mineral sulphur or carbon, composed of carbonic acid and a large quantity of phlogiston," or, as we would express it, of carbon, and showed that it was the insoluble substance that occurred in cast-iron, thus opening the way to the further researches that have been made in the differences between iron, cast-iron, and steel, which, still under prosecution, lie at the foundation of our greatest industries. Connected with this investigation, on account of the resemblance of the minerals to graphite, were his researches in molybdenum and in wolfram. The last resulted in the discovery of the metal tungsten, for which the name *Scheelium* has been proposed.

Very little was known of organic compounds in Scheele's time. It is one of his great titles to merit that he first opened the way to the rich field of the fruitful and enriching discoveries that distinguish the medical and industrial chemistry of our day. The first in order of his researches in this line is his memoir on Prussian-blue, which well illustrates the readiness with which, bringing his extraordinary penetration to bear, he was able to arrive at the truth. In the course of his research he obtained a colorless liquid, which he described as "a substance having a curious odor, but not disagreeable, with a taste somewhat like that of sugar, which heated the mouth slightly and provoked coughing." He little imagined that he had in his hands one of the deadliest poisons known, prussic acid; and we shudder when we think how near it might have come to making an end of him. His researches on the different species of alcohol, described in 1782, indicate that he obtained aldehyde, a substance which has since been the starting-point for numerous important combinations, but of which the discovery is attributed to Liebig, in 1835; he appears also to have encountered chloral in his researches.

The preparations made in his shop led Scheele, in 1783, to the discovery of glycerine, which was at first called Scheele's sweet principle of oils. Boiling oxide of lead with water and oils, he obtained a plaster which he called a kind of hard soap, and which was not soluble in water. Examining the liquid which was left, he observed glycerine.

In a memoir relative to a new method of preserving vinegar (1782), Scheele showed that further change could be prevented by bringing the vinegar to the boiling-point. Scheele was the first to examine the substances which give an acid taste to fruits and plants. To this order belongs his examination of the "salt of sorrel." He also, in one of his earlier scientific labors, isolated tartaric acid, and introduced the method by which numerous other organic acids have since been separated. In 1784 he discovered citric acid in the lemon, gooseberry, and other fruits, and malic acid in the gooseberry and in fruits generally; and shortly before his death he produced gallic acid, or "salt of gall-nuts," from which he distilled pyrogallic acid, which has been found useful in photography. He first found benzoic acid, saccharic acid, and mucic acid. Examining what was called rhubarb-earth, in 1784, he found it to be composed of oxalate of lime, and from this proceeded to show that that substance is generally present in roots and bark.

In animal chemistry, he examined the concretions of urinary calculus, discovered uric acid, observed its connection with intermittent fevers, and prepared alloxane and cyanuric acid. In 1780 he investigated the phenomena of the curdling of milk, and speculated as to its cause, and in this research discovered lactic acid.

Scheele's nomination as member of the Royal Academy of Sciences, in 1775, is said to have been the only public mark of distinction he received in his native land. He was elected to the Society of Naturalists in Berlin, in 1778; and of the Academy of Sciences of Turin, in 1780, in the presence of his king, Gustavus III. His Majesty, it is said, had not heard much of Scheele before this, and was a little astonished, on hearing the eulogies passed upon the newly-elected member, to hear what a great man he had in his states. He was sorry that he had done nothing for him, and decided to make amends; he would confer an order upon him. The minister to whom he gave his directions was puzzled, for he, too, did not know Scheele. The order was conferred—but upon another Scheele than the chemist!

Scheele's collected works were published at Leipsic, in Latin, in 1788–'89, and in German in 1793. His papers in the Royal Academy have been translated into English by Thomas Beddoes, and are published under the title of "The Chemical Essays of C. W. Scheele."

On the 21st of May, 1886, the one-hundredth anniversary of Scheele's death, the people of Köping held an imposing celebration in memory of the man who had distinguished their town by making it the chosen home of one of the founders of the modern science of chemistry; and the representatives of science in Sweden, Germany, France, Switzerland, and other countries, expressed their sympathy in the occasion in appropriate messages.

# CORRESPONDENCE.

## MEDIÆVAL JEWISH SCIENCE.

*Editor Popular Science Monthly:*

SIR: President White, in "New Battles of Science," shows up the reactionary influence of the Christian writers in the middle ages on the knowledge of Nature, beginning with Cosmas Indicopleustes and ending with Albertus Magnus—their denial of the earth's spherical shape, their bringing rain from beyond the firmament, etc., all on the strength of Scripture. Now, I am proud to say that my brethren, the Jewish scholars of the middle ages, did nothing to push science backward, but took it up cheerfully where the Greeks had left it. The two leading philosophic works of middle-age Judaism, both written in Southern Spain, and in the Arabic tongue, are the "Moreh Nebochim" ("Teacher of the Perplexed") of Maimonides, strongly rationalizing, and therefore ill received by many, and the "Cozari" (feigned conversations with a "Chazar," khan, converted to Judaism), of the great Jewish hymn-writer, Jehuda Hallevi, published in A. D. 1140, thoroughly orthodox. He rejects the metaphysics of Aristotle and of Epicurus, but recognizes what Greece has achieved in physics. Speaking of the Sabbath (Part II, § 20), he assumes for the three Eastern Continents an extent of twelve hours, or 180° in longitude, and a like extent for the ocean, which Columbus had not yet parted in two; he puts Jerusalem midway between *Tsin* (China) and westernmost Africa, and tells us that when the Sabbath begins there on Friday evening at six it is midnight in China, and still Friday noon in the extreme West. Not exact, according to our lights, but up to all the light of his own time. Elsewhere he boasts of the astronomic learning of Rabbi Samuel, an early Talmudic writer, and shows that he and his friends studied the stars only for the purposes of the calendar, new moons, and equinoxes, not with any view to horoscopes. He states with pride that, in the rules for killing and examining beasts for food, the Talmud shows more knowledge of the anatomy of the lungs than can be found in Galen. He also claims that long experience had proved the Jewish measurement of the synodic month and tropical year to be more correct than the numbers given by Ptolemy. He finds no occasion to speak of the origins of rains and thunder-storms; but the absurd notion that rain comes from beyond the firmament could never occur to any of the Old Testament writers, who lived on the narrow strip between the Great Sea and the Syrian Desert, and got their rain with the west wind and their dry heat with the dreaded east wind (*kadim*), nor to any one who read their books in the Hebrew text. The "Cozari" proves that in the darkest ages our race kept its mind unclouded.

The opinion that thunder-storms are the work of the devil or of evil spirits could not grow up among a people who were taught from their childhood to greet lightnings or falling-stars with the benediction, "Blessed be thou, O Lord, who doth the work of creation!" and to welcome thunder with the kindred formula, "Blessed be thou, O Lord, of whose strength and of whose might the world is full!" Respectfully,

LEWIS N. DEMBITZ.

LOUISVILLE, KENTUCKY, *July* 24, 1887.

## HATS AND BALDNESS.

*Editor Popular Science Monthly:*

SIR: A few months ago you published in the pages of the "Monthly" an article on hats as a cause of baldness, which has been extensively quoted and has attracted much attention. I have delayed writing to you on the subject until I had leisure to look up an article written by my father, the late Dr. Austin Flint, nearly thirty-five years ago. I send an extract from this article which appeared as an editorial in the "Buffalo Medical Journal," March, 1853, No. 10, page 651, and was entitled "Hats and Baldness": " . . . The most characteristic trait of the hat is the tightness with which it encircles the head. Herein consists, in our opinion, its agency in the loss of hair. The stove-pipe hat must needs encircle the head tightly, in order to be secure in its position in spite of wind and other disturbing forces. To appreciate the degree of compression, one has only to note the indentation on the forehead after a tightly-fitting hat has been worn for some time. Everybody knows how commonly this is to be observed. The head is, in fact, pretty firmly ligated while the hat is worn. Now, what must be the effect of this on the circulation? Plainly, the effect is to interrupt the circulation in the scalp above the circle on which the compression is made. It is precisely like tying a cord around the head, sufficiently to diminish, if not stop, for the time, the flow of blood through the temporal and other arteries by which the blood is distributed to the superior portion of the scalp. The hair-follicles, as is well known, are very vascular. Their functions require this vascularity, and an adequate, constant supply of oxygenated blood. If this supply be diminished, the growth and nutrition of the hairs are proportionally affected; and, finally, the *pulp* inclosed in the follicle withers and dies, as does any other part when deprived of the *pabulum vitæ*. This effect occurs on the crown, because interruption of the circulation in arteries is always felt most in the parts to which the terminal branches are distributed.

"Such is our explanation of the fact that baldness is so frequently observed in the young and middle-aged men of the present generation. The remedy is to repudiate the present fashion of hats. Let some inventive genius devise a substitute for the unseemly, as well as hair-destructive, article which is now the *mode*, and we are firmly convinced that toupees will become objects of curiosity rather than utility, and the bald pate will again be venerated as the distinguishing trait of old age." . . .

Austin Flint, M. D.

No. 14 West Thirty-third Street, New York City, *August* 25, 1887.

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### THE MEANING OF EDUCATION.

*Editor Popular Science Monthly:*

Sir: In an article on "Modern Over-Education" in the July number of "The Popular Science Monthly," taken from "Land and Water," the writer says, "The Latin word *educo*, from which our English word is derived, means simply to draw out or to train."

It will be remembered that there are two words in the Latin, spelled alike, but with somewhat different meaning: the one *ēdūco*, *educere*, meaning "to lead forth," "to draw out," etc., from which we get *educe* and *eduction;* the other, *ĕdŭco*, *educare*, meaning "*to bring up* a child physically or mentally," "to rear," "to educate," also "to nourish," "support," etc. It is from the latter, of course, that we get our word "education," from which it will appear that the idea originally conveyed by it was not simply that of *leading* or *drawing forth*, but of *rearing*, *nourishing*, and the like. It seems to me well to bear in mind that the educator must see to it that the minds placed under his care need nourishment, as well as the drawing forth or training of the faculties, if they are to be properly developed and strengthened. In other words, there must be *wholesome food* for mind as well as for body, besides the necessary exercise or gymnastics.

Mere exercitation, independently of what is presented to the attention, can scarcely be expected to accomplish the best results.

I have ventured to send you this note because I have reason to believe that quite a number mistake the true etymology of our word "education," and that there is something to be gained by a proper consideration of its true origin.

Very respectfully yours,
L. L. Holladay.

Hampden Sidney, Virginia, *July* 9, 1887.

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### AN EXPLANATION.

*Editor Popular Science Monthly:*

Sir: I had not intended to reply to any further communication of Miss Gardener's, but as in her letter, published in your September issue, she accuses me of a willful deception, it seems necessary that I should again address you.

In my paper on "Brain-Forcing in Childhood" I stated that the human head does not grow after the seventh year, and that the hat that is worn at that age can be worn just as well at thirty. For this statement Miss Gardener, in her first communication, called me to an account, and I in my answer admitted, as I thought frankly, that I had made a mistake, and that I should have said *brain* instead of *head*. She now, in her last letter, endeavors to make it appear that I had asserted that, by a slip of the pen or by some other inadvertence, I had said *head* when I meant *brain*.

My language admits of no such interpretation except from one anxious to misinterpret. I made a mistake. I thought the fact was as I had stated it, and when I found out my error, and that it is the brain and not the head that does not grow after the age of seven, I made the proper correction. In all the points necessary to my argument I was right, for the hair, skin, muscles, etc., of the head can not be regarded, even by Miss Gardener, as contributing to intelligence.

Miss Gardener's attack is a quibble altogether unworthy of her. She might properly have censured me for my thoughtlessness or ignorance, but that is all. I have never been ashamed to confess my mistakes, and to allow my adversaries to get whatever comfort from them they can extract, and she is welcome to make the most of my error in this matter.

As to the point in question, it is scarcely to be supposed that, knowing that Miss Gardener was in possession of my whole statement, I should have endeavored to deceive either her or the public in the matter.

William A. Hammond.

[Want of space compels the termination of this correspondence with the present letter.—Editor.]

# EDITOR'S TABLE.

## *ENCROACHMENTS OF THE STATE.*

THE article by Dr. Shaw, in a recent number of the "Contemporary Review," on "The American State and the American Man," has started inquiry as to the extent to which individual liberty is being encroached upon in this country by the extension of State functions. The result has been to show that, in most of the States of the Union, a rapid process is taking place of transference to the government of functions and responsibilities heretofore devolving on the private citizen. It would almost seem as if people had found a new toy—the power of legislative action—and were playing with it with a kind of greedy zest. According to the accounts furnished, there is a perfect rain, not to say deluge, of statutory regulations on every conceivable subject proceeding from our State Legislatures. Acts of incorporation are granted to every body of persons who come forward and claim that it would be a public benefit if they were granted the powers and privileges of a corporation, and intrusted with the control of some particular art or profession. The general result of this legislative activity is that free competition is suppressed, and individuals are released to a large extent from all responsibility of choice as to how or through whom they shall get this thing or that thing done. The State legalizes certain schools of medicine and refuses to legalize others. It makes the taking out of its certificates obligatory on all who would engage in the profession of teaching. It provides for the inspection and stamping of various articles of merchandise. It seeks, as far as possible, apparently, to reduce the life of each individual citizen to a kind of safe mechanical routine. So soon, indeed, as a burden of responsibility begins to be felt in any quarter, some busy law-maker, moved by some interested party, offers to lighten the load by a special act of legislation. What should not be lost sight of is, that there is always somebody who stands ready to make money out of each new law inscribed on the statute-book. Back of the whole body of oleomargarine legislation stands the farmer who does not want his butter-trade subjected to a trying competition. And so with all special laws of a protective kind. We hear of a demand made in one quarter for the incorporation of the music-teaching profession, so that henceforth no one may venture to inculcate the elements of music save in accordance with the views and theories of the incorporators. Of course, these public-spirited ladies and gentlemen, who are so anxious to protect the community from the injury which might be inflicted by ill-prepared music-teachers, have their own interests to serve in the business. Competition will be restricted, and all who want to teach will have to pass through the probation which it may please the incorporators to prescribe. People who want to earn an honest living by imparting the little they know will find their pathway blocked by a special law passed in the interest of the magnates of the profession.

Dr. Shaw, in the article above referred to, says that there is no use in trying to draw a distinction between functions that the State may properly undertake and those which it should abstain from assuming. The sooner, he holds, we come down to the position that every thing is a lawful subject of State interference, and that the question is never more than one of expediency, the better it will be in every respect. We can not view the matter in the same light. We are quite prepared to apply the test of expediency; but we hold that, if it can be shown that there is a large class of subjects which it is not expedient for the State to touch, then it may be said that there is ground which it is not lawful for the State to enter. In applying the test of expediency, however, we would apply it in the broadest sense. We should be careful not to mistake a good intention for a good tendency; nor should we ever consent to overlook the probable effect of any given law upon the character of the community. We should claim to judge it not by its immediate and direct effects only, but by its remote and indirect ones as well, ever keeping in view the principle that the well-being of the community must in the last resort depend on the personal qualities of the men and women composing it. Let others aim, if they will, at the protection of everybody against everything, and the reducing to a minimum the energy, caution, judgment, and courage required for the conduct of life; we shall join in no such crusade. We believe that society possesses, and that individuals possess, powers of adaptation to varying contingencies which the protective spirit in contemporary legislation is greatly tending to obscure and overlay. We want to see individual character more and more brought into prominence as a condition of success, and public opinion developed and educated into a force that can act for good independently of legislative support. As things are going at present, it looks as if the "coming slavery," foretold by a great philosopher, might be hastened beyond the measure of his fears. It behooves all who believe in individual liberty and individual responsibility as conditions of social well-being to raise their voices against a tendency which certainly is hostile to both.

### *THE AMERICAN ASSOCIATION.*

The thirty-sixth meeting of the American Association for the Advancement of Science, which was held in this city in August, was well attended, and made a good record of work. While it was not marked by any papers of unusual brilliancy, or by the announcement of any discoveries or theories of startling import, the papers presented, as a rule, bore evidence of careful, intelligent thought, and had their justification either in embodying discussions of public interest and utility, or as being real contributions to some department of scientific research. That the proportion of papers in which the public is interested was liberal, is shown by the fact that while the daily press selected these for notice, carefully excluding all that was technical, they gave fairly full reports, and such as would be likely to impress their readers that the Association was earnestly engaged in the consideration of living questions. Yet, besides these subjects, the daily programmes of the meeting were laden with topics and investigations in pure science, to which the sections equally gave attention.

The address of retiring President Morse, which we publish, takes up the question of what American zoölogists have done for evolution at the point where the author had left it in his address before the Biological Section of the Association in 1876, and brings it down to the present date. In the sectional vice-presidential addresses, Dr. Brinton reviewed the data for the study of the prehistoric chronology of North America; Professor Alvord, in the Economic Section, talked of the way in which we are wasting the substance of our land in our agricultural exports; Professor Gilbert reviewed the work of the "International Congress of Geologists," which, it appears, is the fruit of a suggestion made at the American Association in 1876; and Professor W. A. Anthony spoke of the importance of teaching physics in the public schools.

The greatest interest was centered in the Economic Section, where a full day was given to the hearing and discussion of the two papers by Professor Atwater, on "The Physiological and Pecuniary Economy of Food," and "The Food of Workingmen and its Relation to the Work done"; and where, at other sessions, President C. M. Woodward, speaking from what had been accomplished under his own supervision, as well as with reference to its practical bearing; and Professor James, looking largely to the future and to the economical side, presented the advantages of manual training in the public schools.

In the Engineering and Mechanical Section, Mr. Edison, by proxy, explained his new pyro-magnetic dynamo, or machine for producing electricity directly from fuel; and Mr. P. H. Dudley described his method for the mechanical inspection of railroad-tracks, by which the slightest flaw or unevenness is detected at once and automatically marked. Professor Ries's method of securing the adhesion of locomotives to railway tracks by the application of electricity, and thus adding to their tractive force without increasing their weight, promises to be of value if it is made practicable.

A joint meeting of the Engineering and Economical Sections was held for the consideration of plans for inter-oceanic communication, at which the merits of the Nicaragua Canal scheme were presented in full. A variety of topics of interest were considered in the Anthropological and Biological Sections; and the transactions of the Physical and Chemical Sections were of interest chiefly to persons engaged in those lines of research.

The Association asked, by resolution, for a reduction of the tariff on scientific books; advised the provision, by act of Congress, of a Bureau of Standards of Measurement for Electricity, Heat, Light, etc.; requested the President to appoint as permanent Superintendent of the Geodetic Survey a man of scientific attainments and trained in that branch; recommended the publication of an index to the publications of the Signal Service; and appointed two committees to secure measures for the preservation of mounds and relics of ethnological and archæological interest—one, to consult with the national authorities respecting relics situated on public lands; the other, with the powers of the States with reference to those within their several territories.

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## LITERARY NOTICES.

The Margin of Profits. By Edward Atkinson. New York: Putnams. 1887. Price, $1.

This work consists of a lecture delivered before the Central Labor Lyceum of Boston, in May last, together with a reply made at the time by Mr. E. M. Chamberlin, and Mr. Atkinson's rejoinder. The object of the lecture was to show that the capitalist is the friend and not the enemy of the laborer, whatever disagreement there may at times be between them. Mr. Atkinson first draws attention to the fact that the margin of profit—that is, the share of the capitalist in the product of industry—is by no means so large as workingmen are apt to suppose. To prove this, he cites the example of the cotton industry, with which he is perfectly familiar, and gives a statement of the entire cost of production, from the raising of the cotton to the completion of the cloth, showing how much is paid out at each step of the process for labor on the one hand and for capital on the other. He illustrates his analysis of the industry by a chart, and gives the following as the result of the examination:

"When you buy forty yards of cotton cloth at two dollars and fifty cents, you pay the owner of the mill fifteen cents profit, but you also pay about fifteen cents more to other people for profit—that is, thirty cents profit in all; and you pay two dollars and twenty cents directly for labor" (p. 28).

It thus appears that in the cotton business the share of the capitalist is only one eighth of the product, while labor gets the other seven eighths; and, according to Mr. Atkinson, there is no other industry in which the capital is so large in proportion to the product as in this.

The author then proceeds to show that the great improvements in the production that have been made in recent times with the consequent increase of capital, though benefiting the capitalist largely, have benefited the laborer still more. He remarks that in his judgment "there has never been a period in the history of the world in which there have been so many important new inventions or so many applications of previous inventions, all tending to human welfare, as in the last twenty-five years" (p. 109). He adds that during this period, "while prices of the necessaries of life have diminished and while the cost of production has been reduced, the wages or earnings of labor, subject to temporary fluctuations, have been steadily increased." And he concludes that "we are not far away from a period when, either with or without legislation, but, as I myself believe, in spite of meddlesome legislation, the arduous struggle for life will be greatly relieved, both in the time which it will be necessary to give and in the intensity of the work which it will be necessary to apply thereto" (pp. 110, 111). In evidence of these statements he cites a number of statistics showing how great has been the fall in prices in many branches of industry since 1860, while the wages of labor have largely increased.

Mr. Atkinson is strongly opposed to the eight-hour law, holding that the hours of labor can not be permanently reduced except by improvements in production; and this is one of the principal points at issue between himself and Mr. Chamberlin. The latter gentleman, however, in his reply to Mr. Atkinson, takes the ground which many other labor-champions do, that capital and labor are natural enemies; that labor, meaning manual labor, is the sole creator of wealth; with other views of like character and as little foundation. His argument for the laborer's cause is, indeed, far from being a strong one, and his opponent has little difficulty in answering it.

Mr. Atkinson's views are given in a plain colloquial style, but often very apt and expressive. He quotes from Emerson the saying that "mankind is as lazy as it dares to be," and tells his hearers and readers that efficiency in work and economy in expenditure are the only means of acquiring wealth and improving one's condition. He estimates that the American people waste on an average five cents a day for each person, which amounts to a thousand million dollars a year for the whole nation. He affirms that the capitalist is the laborer's friend, not his enemy; and that the prosperity of each is necessary to that of the other. He declares it to be "a great blunder to say that, while the rich are growing richer, the poor are growing poorer; it is only the poor who can't work well or who won't work well, who grow poor while the rich are growing rich in this country." And he adds that "there are two things very much needed in these days: first, for rich men to find out how poor men live; second, for poor men to know how rich men work" (p. 47). Mr. Atkinson's work, if read by those to whom it is specially addressed, can not fail to be useful; and it is to be wished that we had more books of a similar character.

Abuse of Alcoholics by the Healthy. By Stanford E. Chaillé, of Tulane University, Louisiana. Pp. 36.

In this paper, which is a part of the transactions of the American Public Health Association, is given one of the most temperate, candid, and useful estimates of the effects of alcoholic drinks on the system that we remember to have seen. A brief review of the history of the use of spirituous liquors satisfies the author that we have no reason to be discouraged respecting the progress of temperance principles and practice; for it "renders it obvious that for many centuries our forefathers have imbued their descendants with faith in the health-giving virtues of alcoholic indulgence. Who can expect the results of such long-continued convictions and customs to be eradicated easily or promptly, and what wonder is it that men continue to credit alcoholics with many virtues that they do not possess?" With regard to the physiological action of alcohol—"Repeated experiments on robust, healthy men have proved that not even the strongest of these can exceed in a day more than two ounces—that is, only four tablespoonfuls—without diminishing their capacity for work. . . . Whoever does not die before his time, and yet habitually drinks more than two ounces of alcohol daily, will very surely have to pay for it in pains far harder to bear than those inflicted by payment in cash." The almost certainty that those who indulge in even this quantity will demand more, is the universal temperance argument. The complaint of those who apprehend that drunkenness is increasing is answered by citations, century by century, which show that as a whole the present is decidedly the most temperate age in history. As to remedies for the evils of drunkenness, the author has much faith in prohibition, and believes that local option is as nearly sovereign as we are likely to attain.

Ten Great Events in History. Compiled and arranged by James Johonnot. New York: D. Appleton & Co. 1887. Price, 63 cents.

This book is intended for young readers; and its object is not merely to teach history, but also to cultivate certain noble sentiments, such as patriotism and love of liberty. The author holds that "patriotism, or love of country, is one of the tests of nobility of character," and adds that "from the earliest times the sentiment of patriotism has been aroused in the hearts of men by the narrative of heroic deeds, inspired by love of country and love of liberty. This truth furnishes the key to the arrangement and method of the present work" (preface). The historical examples which the author has chosen are, in the main, well adapted to his purpose. Some of them, however, can hardly be called struggles for liberty, however interesting and important in other respects, such, for instance, as the Crusades and the conquest of India. The Crusades especially, though having an interest of their own, and, constituting, in one sense, a great historical event, are chiefly memorable as a stupendous example of superstition and folly.

The most interesting portions of Mr. Johonnot's book are those describing struggles for liberty in modern Europe and in our own country. Of ancient events only one is treated—the victorious contest of the Greeks against the Persians. Coming down to modern times, considerable space is given to the struggles of the Swiss with the Austrians and with Charles of Burgundy; to the defense of Scotland by Bruce and his men; and to the gallant and successful fight of the Dutch and the English with the mighty power of Spain. An account is given of the discovery of America, and of the settlement of the Pilgrim Fathers, and the work is fitly closed by a brief sketch of some of the chief battles of the Revolution.

The work is, as the author states on the title-page, a compilation, and some parts of it are quoted directly from other writers. Some of the authors quoted from are inferior in style to Mr. Johonnot himself, which makes one wish that he had written the whole work with his own pen. The book will doubtless find a place for itself and fill it usefully, notwithstanding the many rivals with which it will have to contend.

Indiana: Department of Geology and Natural History. Fifteenth Annual Report. By Maurice Thompson, State Geologist. Indianapolis. Pp. 359.

This is one of the most comprehensive and compact reports of the whole series. Besides presenting the record of the special work done during the year by the department, Mr. Thompson has sought, in a "Compendium of Geology and Mineralogy," by which this is preceded, to give an outline sketch of all that has been discovered and reported upon by his own corps and by his predecessors in office, so that the volume might, in a certain degree, place the student, who can not get the earlier reports, in a situation fairly to understand the geology of the State. In doing this, he has made a treatise that is readable throughout as well as scientifically acceptable. It is claimed that the work of the department, as a whole, has done more than all other agencies combined to advertise the coal, clay, iron, and building-stone of Indiana, and to direct attention to the peculiar advantages offered by their situation and quality. The reports of the former incumbents of the office, though long since exhausted, are still sought for by intelligent inquirers all over the world; and the present chief of the department has found the answering of letters from outside the limits of the State, as well as within them, touching the results of the surveys, no unimportant part of his official duties. Mr. Thompson's "Compendium" includes sketches of the several geological formations, in their order, which are exposed in the State, from the Hudson River Group to the Coal-measures; an account of the building-stones, of which the oölitic limestone of the Sub-carboniferous is considered the best in the world; and descriptions of the clays, chalk-beds, glacial deposits, and terminal moraine which "passes into Illinois from Warren and Benton Counties, and into Ohio from Randolph and Wayne Counties," and may be seen in section in railroad-cuttings just south of Lafayette. Attention is called in a special study by S. S. Sorby to the *Wabash Arch*, a line of disturbance whose general direction is indicated by its name, which, it is believed, may have some connection with the occurrence of natural gas. A paper on the "Origin of the Indiana Flora," considered with reference to localities as well as in general, is contributed by Professor Coulter and Harvey Thompson; Mr. Thompson describes the Post-Pliocene mammals and the developments of natural gas; and Mr. Sorby gives a study of the prehistoric race of the State. The report of the year's special work includes the surveys of thirteen counties or parts of counties in the central and northern central parts of Indiana.

Home Sanitation. By the Sanitary Science Club of the Association of Collegiate Alumnæ. Boston: Ticknor & Co. Pp. 80.

The club which avows the responsibility for this book was organized in November, 1883, for the study of home sanitation. It found, after two years of devotion to this purpose, that the expenditure of time and effort had been "amply repaid by positive and satisfactory results"; and that it had a store of information, derived from the experiences and observations of its members, worthy to be given to the public. This information is embodied, in the form of preliminary statement and questions, in short chapters on the "Situation of the House and Care of the Cellar," "Drainage and Plumbing," "Ventilation," "Heating," "Lighting," "Furnishing," "Clothing," "Food and Drink," and "Sanitary Work for Women." The important part of the text is in the questions, which suggest more than they express or than is conveyed in the statement above them, and "are so framed that an affirmative answer implies a satisfactory arrangement, and also suggest a remedy if the answer is negative." They have been practically tested by the members of the club in their own homes and by other housekeepers, and have been adopted as the basis of a course in sanitary science offered by the Society to Encourage Studies at Home.

Geological Survey of New Jersey. Annual Report of the State Geologist for the Year 1886. By George H. Cook, State Geologist. Trenton: The John L. Murphy Publishing Company. Pp. 254.

The report, which simply records the work done during the year, is arranged under the four heads of "Geographic Surveys," "Geological Surveys," "Economic Geology," and "Miscellaneous Items." The work of the geodetic and topographic surveys, though it has all been under the direction of the State Geologist, has been done at the expense chiefly of the United States Coast and Geodetic and Geological Surveys. The work has been going on for twelve years, and will require two years more for completion. Under it the latitude and longitude have been precisely determined for four hundred and fifty-two points, which stand at an average distance of about twenty-five miles apart. The topographic survey has been rapidly advanced, and has been carried over a larger area than in any previous year, and now covers eighteen hundred and ninety-seven square miles. The results are to be recorded in engraved maps on a scale of one inch to a mile, of which there will be seventeen, twenty-seven by thirty-four inches in size. The contour-lines are drawn on these maps so as to show every change of twenty feet in elevation in the hilly portions of the State, and of ten feet in the more level portions. Another important work in this department has been the fixing of bench-marks for the accurate determination of elevations, which, besides being capable of practical use in many ways, will be serviceable in the future for the detection and measurement of whatever changes of levels may take place. The tides have been made subjects of observation, and show peculiarities, particularly in the bays, which indicate that much is yet to be learned about them. The department of "Geological Surveys" is largely occupied by a close study, by Dr. N. L. Britton, of the "Archæan or Primitive Rocks of Northern New Jersey," illustrated by sections and colored maps, and of their minerals. The "Palæozoic Rocks of the Green Pond Mountain Range" are described by Mr. F. J. H. Merrill; the theory of the Triassic rocks receives further discussion; and the "Yellow Gravel" of the region south of the terminal moraine is the subject of a special report. The department of "Economic Geology" includes the reports of the mines and a republication to meet frequent calls for information, of a special report made in 1876, on the greensand marls. An account is given of the successful drainage of the Great Meadows on the Pequest, in Warren County, and their conversion into excellent farming-lands; and a strong presentment is made of the necessity of draining the meadows of the upper Passaic.

Fourth Annual Report of the Bureau of Ethnology to the Director of the Smithsonian Institution. J. W. Powell, Director. Washington: Government Printing-Office. Pp. 532.

The work of the Bureau has been prosecuted on the plan of employing scholars trained in the special researches contemplated, to conduct the necessary investigations and present results for publication. Attention has also been given to promoting and guiding research on the part of collaborators not officially connected with the Bureau, and results of value have been gained in this way. The principal researches mentioned in the present report are mound explorations in West Tennessee and Arkansas, under the direction of Dr. Cyrus Thomas; explorations of cave and cliff dwellings in the cañons of New Mexico and Arizona; Mr. Cushing's Zuñi researches; Mr. Victor Mindeleff's researches among the Moki; photographs of aboriginal ruins, by Mr. J. K. Hillers; work in linguistics, by Mr. J. O. Dorsey; Mrs. E. A. Smith, Dr. J. W. Hoffmann, and Dr. Washington Matthews; and the compilation, in the office, of papers embodying the collected results of field-work, in which many of the correspondents of the Bureau have participated. Several of these papers are given as "accompanying papers" to the report. They are an elaborate treatise or "Pictographs of the North American Indians," by Garrick Mallory, which is profusely illustrated; "Pottery of the Ancient Pueblos," "The Ancient Pottery of the Mississippi Valley," "Origin and Development of Form and Ornament in Ceramic Art," all by William H. Holmes; and "A Study of Pueblo Pottery as Illustrative of Zuñi Culture-Growth," by F. H. Cushing. The illustrations to the whole volume include eighty-three full-page plates and five hundred and sixty-five figures in the text.

Proceedings of the American Society of Microscopists. Ninth Annual Meeting. Chautauqua, New York, August 10 to 13, 1886. D. S. Kellicott, Secretary. Buffalo, New York. Pp. 243.

This volume contains, besides the accounts of the sessions, reports, and other matters of regular recurrence, twenty-four papers on subjects connected with microscopic science and manipulation. Among the papers of more general interest are the annual address of the president, Thomas J. Burrill, on "Bacteria and Disease"; Mr. R. H. Ward's "Remarks on Making Microscopical Societies Successful," which are of interest to every one concerned in such societies or contemplating the formation of one; Professor H. A. Weber's "Microscopical Examination of Butter and its Adulterations"; Mr. Ernst Gundlach's "Optical Errors and Human Mistakes"; and Mr. Charles E. West's relation of his "Forty Years' Acquaintance with the Microscope and Microscopists."

Annual Report of the Board of Regents of the Smithsonian Institution to July, 1885. Part I. Washington: Government Printing-Office. Pp. 996.

Under the operation of an act of Congress permitting the printing of the Smithsonian reports, like those of the heads of departments, previous to presentation to the two Houses, this volume appears earlier than has been usual. It also covers a shorter length of time, or only half of the year. The report reviews the progress of work in all the departments of the Institution; the explorations in which it has been interested, in all parts of North America, with researches in the remains of prehistoric man in parts of France; publications, including Dr. Rau's "Prehistoric Fishing in Europe and North America"; Vols. XXIV and XXV of the "Smithsonian Contributions to Knowledge"; the "Smithsonian Miscellaneous Collections," in which are included several monographs; the scientific writings of Professor Joseph Henry; the "Report on the Reptiles and Batrachians of North America"; the "Bulletin," and "Proceedings" of the National Museum; and the publications of the National Museum. Information is given concerning international exchanges, and lists of some four thousand foreign correspondents and of the institutions in the United States to which the Smithsonian publications are sent. In the "Appendix" are found the record of scientific progress in 1885, in the several departments of research; various papers relating to anthropology; an "Index to the Literature of Uranium," by H. Carrington Bolton; and a priced list of Smithsonian publications.

Willem Usselinsk, Founder of the Dutch and Swedish West India Companies. By J. Franklin Jameson. New York: G. P. Putnam's Sons. Pp. 234, paper. Price, $1.

This memoir is one of the papers of the American Historical Association (Vol. II, No. 3). It is devoted to one of that class of promoters of American settlement to whom the author thinks that less than full justice has been given—"of those who, without themselves having come to this country, or shared in the picturesque adventures of the age of settlement, stood behind all efforts toward colonization, and assisted them in ways more prosaic, but not less efficient, nor less deserving of grateful remembrance—the class of colonial projectors. . . . It is the object of the present essay to relate in sufficient detail to enable its importance to be correctly estimated, the career of a member of this latter class, a man almost unknown to the English-reading public, yet who was, though not directly the founder, at any rate the originator of two of our colonies—that upon the Hudson, and that upon the Delaware." In another place Usselinsk is styled "the Lesseps of the seventeenth century." The materials for the biography have been derived from the books and pamphlets of Usselinsk, his manuscripts, and manuscripts concerning him. The abundance and scope of these sources are illustrated by the copious bibliography which is affixed to the end of the work.

Voice, Song, and Speech. By Lenox Browne and Emil Behnke. New York: G. P. Putnam's Sons. Pp. 248.

This is the seventh edition of a work to the merits of which we have already called attention in a notice of a previous edition in the "Monthly" for July, 1884. It owes its origin to the fact that each of the authors—one a surgeon, and the other a teacher—having contributed to the literature of the human voice, both found their views one-sided and needing to be complemented from the experience of the other. They therefore joined to produce a single comprehensive work. In the present edition, as well as in the sixth, the substitution of engravings for the expensive photographs of the larynx and soft palate has made possible a very considerable reduction in price from that of the earlier editions.

Local Government in Canada. By John George Bourinot. Baltimore: N. Murray. Pp. 72. Price, 50 cents.

This is an historical study in the series of Johns Hopkins University. The author, by the public positions he has held, and by the preparation of an account of the "Origin and Growth of Parliamentary Institutions in the Dominion," has enjoyed excellent opportunities for qualifying himself for this special research. His attention was drawn to the subject through the interest awakened by reading the histories of local government in various of our own States, which have appeared in this series. He was convinced that a similar paper on local government in Canada would be of value to students of political science. The political history of the Dominion is divided, for the purposes of the study, into three important epochs: The era of the French *régime*, from 1608 to 1760; the period of slow growth and accruing experience in the working of representative institutions under British rule, 1760 to 1840; and the period of enlarged political liberties and responsible government, 1840 to 1867. "Since 1867, the various provinces, united as the Dominion of Canada, have entered on a fourth era, pregnant with promise."

Bulletin of the Scientific Association. Peoria, Illinois. 1887. William H. Park, Recording Secretary. Pp. 92.

According to the historical address of Dr. J. T. Stewart, the Association was organized in 1875, as a summer school for the study of the natural sciences, at which Professors Wood, Hyatt, Wilder, and Comstock lectured. Meetings were held monthly, except in summer, for seven years, and afterward weekly. During the period of the society's existence, two hundred and two papers have been read, on a wide range of subjects of scientific interest. The society began with thirteen members, and now has one hundred, while the average attendance upon the meetings has increased from about twelve to one hundred and five. The museum contains more than ten thousand specimens, and the herbarium embraces the entire flora of the Peoria section, "and more," and the records of visitors to the rooms show that interest in the collections is growing fast among the public. Besides a number of papers having a broader scope in discussion, the "Bulletin" contains articles of more special interest on the geology, paleontology, flora, climate, and coleoptera of Peoria and its vicinity, a study of "The Lake as a Microcosm," and a memoir on the "Immigration of Animals and Plants."

Third Annual Report of the Commissioners of the State Reservation at Niagara. Pp. 37.

The commissioners report the reservation nearly clear of obstructions, only two of the old buildings yet remaining on the premises, and one of them to be removed shortly. Improvements have been made in many of the appurtenances of the property, for the convenience of visitors and greater security. Plans were in preparation for the restoration of the scenery of the shore and islands. Some of the fruits of the work of the commission are seen in the improved government of the village of Niagara Falls. A company having been formed to build a railroad along the gorge of the river from below the Falls to the Whirlpool, an act has been secured protecting the reservation against intrusion. The commissioners regret that the whole *débris*, slope from the Falls to the Whirlpool has not been included within the reservation. The Falls were visited during the excursion season by 187,781 persons coming in excursion trains, and probably as many in regular trains. The stay of the visitors is "longer than in former years." The latest measurements give the rate of recession along the whole contour of the Horseshoe Fall since 1842 as about two and four tenths feet per year. The recession of the American Fall has been slight. The heights above the level of the water in the river are, American Fall, one hundred and sixty-seven feet; Horseshoe Fall, one hundred and fifty-eight feet. It is estimated that more than one thousand species of flowering plants and ferns are native at the Falls or in their neighborhood.

Report of the Commissioner of Education for the Year 1884–'85. By John Eaton. Washington: Government Printing-Office. Pp. 848.

The present (the fifteenth) annual report of Commissioner Eaton is the last of the series prepared by him. The year has afforded abundant evidence of the value attached to the annual reports of the Bureau in the demand for copies at home and abroad; and, in consideration of this fact, the Commissioner emphasizes the need of uniformity in the general plan and nomenclature of State and local reports, as a means of facilitating analysis and comparative study. Attention is called to several particulars in respect to school attendance. The actual attendance is undoubtedly increasing, but improvement in respect to regularity is not so decided as could be wished. "One of the chief hindrances to the progress of our common schools is the multiplicity of school districts and of independent local authorities. . . . Wherever these 'petty school sovereign-ties' have been abandoned, the schools are flourishing; where they are maintained, the reverse is true. Among hopeful indications for the future of the common schools are the efforts for the improvement of the teaching force and for bringing the rural schools under efficient supervision, and the increase of the local school-tax in sections of the country which have hitherto been negligent of that provision." Brief histories are given in the report of "Governmental Provisions for Education," and of the growth of State and local educational reports. Space is given to the discussion of the methods of colleges, and of the development of the university system, and to the subject of industrial training; and the usual full and detailed information is given concerning the schools in the several States; the different classes of schools for special and the higher instruction; and to the record of educational progress in other countries.

The Latest Studies on Indian Reservations. By J. B. Harrison. Philadelphia: Indian Rights Association. Pp. 232.

The author, as a representative of the Indian Rights Association, spent six months in 1886 in visiting the schools at Carlisle and Hampton, and the principal Indian reservations. His purpose was to observe whatever was connected with the condition and character of the schools, farming, home-life, and missionary work, and the general and special relations of the Indians to civilization and their progress therein; the character and efficiency of the administration of affairs; and the quality of Indian land and its adaptation to sustain an agricultural population. This book embodies, in terse language, the results of his observations. The first part of it consists of picturesque descriptive notes of what he saw; the second part, of opinions and reflections suggested to him by it.

Poetry and Philosophy of Goethe. Edited by Marion V. Dudley. Chicago: S. C. Griggs & Co. Pp. 300.

This book comprises the lectures and *ex-tempore* discussions that were given before the Milwaukee Literary School in August, 1886. They are an "Address of Welcome," by President John Johnston; "Goethe's Wilhelm Meister," by Professor W. T. Harris; "Goethe as a 'Scientist'," by Mr. James MacAlister; "Goethe's Relation to English Literature," by Mr. F. B. Sanborn; "The Divine Comedy and Faust," by Mrs. Caroline K. Sherman; "Mythology of the Second Part of Faust," by Professor D. J. Snider; "The Elective Affinities," by Mrs. M. A. Shorey; and "What is most valuable to us in German Philosophy and Literature," by Professor W. T. Harris. To these are added "Some Birthday Tributes," including essays on "Goethe as a Man," by Professor W. T. Hewitt; and "Goethe as a Writer, Savant, and Citizen," by Mrs. Horace Rublee; a letter by Goethe, poetical tributes, and an analysis of "The Erl-King."

Miscellaneous Papers relating to Anthropology. From the Smithsonian Report for 1885. Washington: Government Printing-Office. Pp. 49.

The first paper in this group—"Observations on Stone-Chipping"—by George Ercol Sellers, gives the results of the author's personal observations and researches regarding a prehistoric art of which little is known, and adds to our knowledge on the subject. The other papers, each also having its own peculiar interest, are on "Copper Implements from Bayfield, Wisconsin," by Colonel Charles Whittlesey; "Ancient Remains in Ohio," by J. P. MacLean; "A Primitive Store-house of the Creek Indians," by Charles C. Jones, Jr.; "Shell-Heaps and Mounds in Florida," by James Shepard; "Ancient Earthworks in China," by Mark Williams; and a "Plan for American Ethnological Investigation," by the late Henry R. Schoolcraft.

The Doctorate Address delivered at the Semi-Centennial Anniversary of the University of Louisville, Medical Department. By David W. Yandell, M. D. Pp. 26.

Dr. Yandell gives a retrospect of the history of the institution, which was founded in 1817, with brief notices of the many distinguished physicians who have filled chairs of instruction in it. Among these were Dr. Benjamin Silliman, Jr., and Dr. J. Lawrence Smith, who also became famous in general science. A view is also given of the advance that has been made in fifty years in the opportunities for medical instruction. When the university was established, it was the fourth medical school founded west of the Alleghanies. Louisville alone now has as many medical schools, and there are almost as many between the Ohio River and the Pacific Ocean, as the university is years old.

Contributions to the Anatomy of Geococcyx Calfiornianus. By R. W. Shufeldt. Pp. 281, with Four Plates.

Geococcyx is the ground-cuckoo. The author had already published a paper on the genus in 1886. The present memoir, which is based on a specimen obtained in California, may be considered a second installment on the subject. While ornithologists usually place the genera *Geococcyx* and *Coccyzus* in the same sub-family, *Coccyginæ*, the author's examination discloses anatomical characters in his specimen which are essentially different from the corresponding ones as found in the true cuckoos. He therefore proposes for them two sub-families—the *Centropodinæ*, to contain the ground-cuckoos; and the *Cuculinæ* for the true cuckoos; these, with the third sub-family, *Crotophaginæ*, to make up the family *Cuculidæ*, or North American cuckoos.

List of Astronomical Observatories. By George H. Boehmer. Washington: Government Printing-Office. Pp. 16.

The list simply gives the names of the observatories and the places where they are situated, classified as "American" and "Foreign." The arrangement is alphabetical, by the names of the places.

American Jurassic Mammals. By Professor O. C. Marsh. Pp. 20, with Four Plates.

The author, who is in possession of all the known remains of mammals from the Jurassic in this country, had already published several articles descriptive of them; but a large amount of new material has been secured, including representatives of several hundred individuals, and bones of various parts of the skeleton. The fossils, though fragmentary, are usually well preserved; but, as a rule, no two bones of the skeleton are found together. This fact, with the diminutive size of the animals and other circumstances, makes investigation difficult. The first specimens discovered in this country proved to be very near allies of European forms; later ones resembled others described by Owen, but, as the skeletons were more complete, differences appeared. A few American genera have no known representatives in Europe, while some forms found there are unknown here.

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# POPULAR MISCELLANY.

**Economy of Food.**—In his American Association paper on "Economy of Food," Professor L. O. Atwater laid down the principle that "the cheapest food is that which furnishes the actually nutritive materials at least cost." The nutriments of vegetable food are, he said, in general much less costly than the animal foods. The animal foods have, however, the advantages of containing larger proportions of protein and of fats, and the protein at least in more digestible forms. Flour, meal, and other staple vegetable foods, furnish the nutriments at only a fraction of their cost in ordinary animal foods. At market prices, current in the Eastern States, the cost of the protein ranges at from eight to thirty-four cents a pound in the staple vegetable foods, and from eighteen cents to somewhat over one dollar a pound in the staple animal foods. In oysters it ranges at from two to three dollars a pound, in salmon sometimes to five dollars a pound, in beef at from ten to twenty-five cents a pound from about forty cents to one dollar and ten cents. In many of the usual food-fishes the nutritive material is dearer than in beef. The less expensive kinds of meat contain as much nutriment as the costlier kind; and the different grades of flour have a much more nearly equal nutritive value than is commonly supposed. Among the vegetable foods, wheat-flour, corn-meal, and other cereal products are in general the cheapest and most economical. Wheat-flour at six dollars a barrel and potatoes at forty cents a bushel would furnish nutritive material at about the same cost. The prices of the choicer food-materials are regulated by flavor as well as by the amount of nutritive material, which in some is hardly a fraction of the price. With exceptions that are easily explained, the prices of foods that are bought and used for their nutriment tend to shape themselves proportionately according to the actual values. Taking the world through, the mass of people select those foods which furnish the actual nutrients at the lowest cost; but there are marked exceptions in the United States, where many, even among those who desire to economize, use needlessly expensive kinds of food. "They too often endeavor to make their diet attractive by paying high prices in the market rather than by skillful cooking and tasteful serving at home." Wastefulness of food shows itself in the purchasing of more than is needed; in using part of the excess to overload the alimentary organs and throwing the rest away; in purchasing food that seems cheap but is really dear; in using costly materials where less expensive ones would serve as well; and in the false economy of using too little of one material and too much of another. Great evils accrue from these practices, in the loss of money and the deterioration of health; and "some of the wisest students of physiology and hygiene are persuaded that improper eating, and especially overeating, is a source of more disease than any other one thing."

**Virtues of Mountain Air.**—It may be received as proved that mountain air is good in cases of consumption. Why it is so, may be explained by reference to the qualities of the air of great altitudes, among the most conspicuous of which are its purity, its rarefaction, and its coldness. All modern observers, says the "Lancet," are agreed that pure air is the most essential requisite in the treatment of the scourge. Pure air is not to be found near the great centers of human population, nor even in ordinary lowland country. To obtain it in perfection we must look to the ocean, the desert, or to great altitudes. In these three localities we are far removed from the ordinary sources of atmospheric contamination, and it is hardly necessary to seek to assign any precedence among them, as in each case the atmospheric purity is practically absolute. The next and most essential characteristic of the air, at great altitudes, is its rarefaction, by virtue of which it provokes deep and full respirations, thus promoting pulmonary expansion, and affording a favorable condition for the absorption of morbid deposits. It was long believed that rarefied air tended to promote hæmorrhage, and the well-authenticated stories of the sufferings of mountaineers from epistaxis and melæna, seemed to confirm the belief. But it was forgotten, when these stories were brought forward, that the conditions of blood-pressure at the various orifices are different from those which prevail in the internal organs. The congestion at the surface of the body must be accompanied by a proportionate anæmia of the deep-seated parts, and among them of the lungs. Hence, rarefaction of the air, so far from being injurious in cases of pulmonary hæmorrhage, affords a means for its arrest and relief. Cold is now known to be at least not unfavorable in phthisis. The air at great altitudes is not only very cold, but also very dry; and this combination of conditions tends to correct unhealthy secretions, while it is, at the same time, promotive of appetite and physical activity. This point is one of great magnitude.

**Clothes-Moths.**—Clothes-moths, injurious to woolen goods and furs, are of the species of *Tinea—pellionella*, *bisselliella*, *tapetzella*, or *rustica*. The most common one is *Tinea pellionella*, which in its mature state carries about half an inch expanse of wings. Its fore-wings are shining, grayish-yellow, with three indistinct brownish spots in the middle, and its hind-wings are whitish-gray. It is abundant in houses, and may be found at any time between January and October, though most abundantly in the early summer months. The moth is innocent. The larva, which does all the damage, is a tiny caterpillar, dull whitish, with a reddish-brown head. It is the only one of the four species that makes a tunic or movable case for itself. This case is very ingeniously constructed, and consists of an outer layer of fragments of the articles it has fed upon, and an inner layer of silk, forming a soft and smooth lining. It is nearly cylindrical in form, but of slightly larger diameter across the middle, and a little flattened above, and it is open at both ends. These cases are varied in their appearance, and of different colors, according to the color of the goods from which they are formed. The case is enlarged as the insect grows, both by adding to its length and to its circumference. For the latter enlargement, the case is split and patched up in two slits at each end, with an ingenuity that borders on intelligence. The chrysalis state is assumed inside of the case, the caterpillar becoming, by throwing off its last larval skin, a little, yellowish-brown, helpless thing, similar in form to the chrysalides of the larger moths. The chrysalis is anchored by fine threads to the cloth in which the insect lives. From this the perfect insect emerges, when its time has been fulfilled, lays its eggs, and then dies. The eggs are extremely minute, and are deposited on the cloth, or in crevices and corners close to a supply of food. The young grubs begin life by attacking the old cases of their progenitors, with which they make cases for themselves, and begin to feed on cloths proper at a later period of life.

**Polished Objects of Silicified Wood.**—Mr. George F. Kunz, in exhibiting before the American Association polished specimens of jasperized and agatized woods from Arizona, referred to the description of these woods which he had published in the "Monthly" for March, 1886, their magnificent colors, and their capacity, on account of the large sections which they would afford, to furnish art-objects of unexampled qualities. Although it was thought that sections two or three feet in diameter might be produced, it has until very recently not been possible to get such sections polished. At last machinery was found competent to do the work; and Mr. Kunz was able to show some beautiful large specimens, which had been cut by a gang of seven saws and polished at Sioux Falls, Dakota, by water-power from the falls, on wheels fourteen feet in diameter. The objects exhibited included one column eleven and a quarter inches wide and twenty-one inches high, cut transversely across the tree so that the heart was visible on two sides of it, with the radiations in all directions; also five sections, measuring twenty-five, nineteen and a half, twenty-four, seventeen and a half, and thirteen inches in diameter, respectively, so highly polished that, when turned with the back to the light, they formed a perfect mirror. All of the specimens were brilliant in color.

**Telephonic Communication between Ships.**—Professor Lucien E. Blake described in the American Association a method which he had conceived in 1883 for making telephonic communication between ships at sea. A sound-producing apparatus was to be attached to each vessel, and to be worked under the surface of the water; and each vessel was also to have a sound-receiving apparatus, to take up the signals from other vessels. Signals, intelligible by means of a code, could be produced by this apparatus, which would be transmitted in all directions through the water with a velocity four or five times that in the air. For steamships the sound-producing apparatus was designed to be a steam fog-horn or whistle, specially constructed to sound under water, and to be heard at least six or eight miles off. With such whistles, a Morse alphabet, of long and short blasts and pauses, was to provide a means of extended communication, while a simple universal code would indicate a ship's course. Since ignorance of the very presence of a ship, rather than incorrect estimates of her course, has been the principal cause of ocean collisions, the simple hearing of the sound would prove a most excellent general safeguard. Bell-buoys were to have a second bell added under water, while lightships, lighthouses, and any headlands might also be provided with submerged bells, which could be rung from the shore when necessary. Sailing-craft would also have bells, which, if like ordinary locomotive-bells, could be heard at least two miles under water. By the method described, in October, 1885, signals were transmitted and received through one and a half mile in the Wabash River from a locomotive-bell, around three or four windings of the stream.

**Teaching Physics in the Public Schools.**—Professor W. A. Anthony, speaking in the American Association, Section of Physics, on the importance of teaching physical science in the public schools, said that proper scientific instruction in the primary schools would teach children to avoid the mistake of attempting the impossible. While grammar should be put off to the last, language should be taught by reading, not by rules; the geography, after teaching the form of the earth, should be used only as a book of reference; and the commercial departments of arithmetic should be relegated to the business-school; children in their earliest experiences have to do with heat, light, sound, movement, and magnetism. Physics should be taught by calling attention to familiar facts, and then explaining them.

**Effect of Light on Bacteria and other Organisms.**—Messrs. Downes and Blunt, in two papers read before the Royal Society in 1877 and 1878 on the effect of light on bacteria and other organisms, and on protoplasm, announced the conclusion that light is inimical to these organisms, and under favorable circumstances may wholly prevent their development. The effect was shown to be due to oxidation, which was stimulated by light, and ended in the extinction or in the great depression of the vitality of the organisms submitted to it. The authors furthermore declared that the maximum of the oxidizing effect was near the violet, or in the more refrangible rays, and was comparable with the chemical phenomena of photography. When we come to the other end of the spectrum, the yellow and red, or more refrangible rays, we find that they promote the formation of chlorophyl and so turn vegetation exposed to them green, favoring the growth of green plants. In this we may discover one of the purposes which chlorophyl fills—as that of a special coloring-matter to the plant to filter out the more injurious rays and protect the delicate protoplasmic cell-contents from their destructive action.

**Healthy and Unhealthy Occupations.**—The English Registrar-General has made a comparison between healthy and unhealthy occupations. Assuming the normal average death-rate of the community as the unit of comparison, and calling it 1,000, particular occupations may be regarded as healthy or unhealthy according as the death-rates among those pursuing them fall above or below that figure. The most healthy occupation appears to be that of ministers of religion, whose rate is 556. Next are gardeners and nurserymen, 599; farmers and graziers, 631; agricultural laborers, 701; schoolmasters, 719; and grocers, coal-merchants, paper, lace, and hosiery manufacturers, wheelwrights, ship-builders and coal-miners, with all of whom the average death-rate is under 775. The most unhealthy occupations are the trades connected with the liquor-traffic and hotel service, with which the death-rate is 2,205; following these are general laborers in London, 2,020; costermongers, bankers, and street sellers, 1,879; innkeepers, etc., 1,521; and brewers, 1,361. After the trades concerned with alcohol, the highest rates are furnished by occupations that involve the breathing of dust—other than coal-dust—and exposure to lead-poisoning. The death-rate among butchers is also high, 1,170.

**Cause of Thunder.**—M. Hirn explains thunder and the explosive noise of meteorites by observing that the air traversed by an electric spark—that is, a flash of lightning—is suddenly raised to a very high temperature, and has its volume considerably increased. The column of gas thus suddenly heated and expanded is sometimes several miles long; as the duration of the flash is not even a millionth of a second, it follows that the noise bursts forth at once from the whole column; but for an observer in any given place, it begins when the lightning is at the least distance. In precise terms, the beginning of the thunder-clap gives us the minimum distance of the lightning, and its duration the length of the column. The author points out that a bullet whistles in traversing the air, so that we can to a certain extent follow its flight; the same thing happens with a falling meteorite just before striking the earth. The noise actually heard has been compared to the flight of wild geese, or to the sound produced when one tears linen; it is due to the fact that the air, rapidly pushed on one side in front of the projectile, whether bullet or meteorite, quickly rushes back to fill the gap left in the rear. The velocity of the meteorite is so great that the matter on its surface will be torn away by the violence of the gaseous friction produced, and will be vaporized at the same time by the heat. This is undoubtedly the origin of the smoke which meteorites leave trailing behind them. With this velocity the sound following the meteorite is vastly deeper and more like thunder than that which attends the passage of the relatively slow-going bullet.

**Prehistoric Chronology of America.**—Dr. D. G. Brinton, Vice-President of the Anthropological Section of the American Association, gave there a "Review of the Data for the Study of the Prehistoric Chronology of America." The resemblances between American legends and Oriental myths were considered accidental. The annals of the Mexicans, the Mayas of Yucatau, and the Quichas of Peru, carry us back hardly more than five hundred years. The recollections of the more savage tribes did not extend back more than two centuries. A calm weighing of the testimony respecting the stone buildings of Mexico, Yucatan, and Peru, places them all well within our own era, and most of them within a few centuries of the discovery. The much more ancient artificial shell-heaps along the coasts furnish data to prove that the land was inhabited several thousand years ago. The industrial activity of man in America may be traced by the remains of his weapons, ornaments, and tools, made of stone, bone, and shell. Specimens of polished stone and pottery testify to a reasonably-developed skill; but in the Trenton gravels and a few other localities, genuine palæolithic remains have been found, putting man in America at a date coeval with the close of the Glacial epoch, if not earlier. Vast antiquity is further proved by the extensive dissemination of maize and tobacco, and by the existence of about two hundred radically different languages, both of which must have required long periods of time in development. The American race is distinctively a race by itself, and appears so in the oldest crania from the Quaternary.

**The Food of American Workmen.**—In his American Association paper on "Food of Workingmen and its Relations to Work Done," Professor L. O. Atwater said that statistics of the dietaries of considerable numbers of Americans, mostly of the working-classes, show that their food is ample in amount, and includes large proportions of meat. Chemical examinations of the dietaries showed them to be richer in actual nutritive material and potential energy than even the large quantities would imply. This is because they contain so great proportions of meat and other nitrogenous and fatty substances. Comparing the standard of diet prevailing among the workingmen of Massachusetts with that of Germany, it is shown that laborers in Massachusetts average just about one half more than the German standard requires. It thus appears that the food of the American laboring-man is much more nutritious on the average than that of his European competitors. It is also shown that he turns off much more work than the European workingman. He is better paid, better housed, better clothed, and better fed than the European. He has better opportunities for self-development, more to stimulate his ambition, and more hope of reward if his work is efficient. These factors are all connected, but the explanation of his superior capacity for work is to be found largely in his superior nourishment.

**Optimistic and Pessimistic Diseases.**—Dr. Charles Porter Hart read a paper in the American Association "On the Correction of Certain Mental and Bodily Conditions in Man," the burden of which was to indicate that diseases located above the diaphragm are optimistic in their tendencies, while those below the diaphragm are pessimistic. His attention was first called to the subject by a patient who, suffering from an abdominal disease which seemed to produce a mental aberration, possessed most decidedly pessimistic views. Upon every subject that could be suggested—social, governmental, or religious—his views were of a markedly gloomy character. According to the table of disease-tendencies which the author has constructed, chest-diseases give buoyancy to the system, abdominal diseases are depressing, and diseases of a constitutional and chronic character, like rheumatism, malaria, and dropsy, are equally pessimistic and optimistic.

**The Physical Aspect of Economics.**—Mr. P. Geddes, in a British Association paper on "The Physical Aspect of Economics," said that the present isolation of economic from physical and biological studies, in spite of the clear dependence of the social sciences on the preliminary one, was to be accounted for, not on rational but simply on temporary grounds—that of the pressure of detailed labor upon every specialist. Yet, the sciences were needed on every hand. The population question was a strictly biological one. So, too, was that of competition, and even of individualism *versus* socialism, which largely came down to a dispute between the advocates of natural and artificial selection respectively. The popular idea of progress, as lying essentially in the quantity of wealth and in the number of population, needed thorough replacement of the scientific one—that of the improved average individual quality of the organisms composing the society, and of the material surroundings upon which their evolution depended.

**The Falls of the Orange River.**—Mr. G. A. Farini, who has recently made a journey across the Kalahari Desert in South Africa, succeeded in seeing and photographing the falls of the Orange River, which he was told could not be done. "We had," he says, "to swim rapids, climb rocks, and descend precipices by ropes in order to take the views. The river is broken up into many streams by huge rocks and bowlders, some of them rejoining to form the main waterfall, and others cutting out separate channels to the great gorge, some four hundred feet deep and sixteen miles long, worn in the solid granite. These streams form many rapids, and, when the river is half full, rise and form over a hundred separate cascades, unsurpassed for beauty and picturesque grandeur. When the river is full, many of them join to make one mighty sheet of water, rivaling the great Niagara, as it pours into the abyss nearly four hundred feet below. At low water, the only time it can be approached, the Hercules Fall is one hundred and sixty-five feet high, with several smaller falls at the sides, which are three hundred and fifty feet high, and are caused by the same water before it reaches the main fall."

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## NOTES.

Pertinently to an expression of doubt by Mr. David A. Wells in one of his articles on Mexico, as to the Aztecs having knowledge or making use of metal tools, Mr. W. W. Blake, in the "American Antiquarian," mentions as being on exhibition in the Archæological Rooms of the National Museum of Mexico, idols, beads, and engraved clasps of gold; lip-ornaments and other articles of silver; numerous tools, weapons, and ornaments of copper; and "chopping-knives" of copper, which are supposed to have been used as money.

Nine tenths of wild animals in confinement are said by a medical writer to be subject to heart-disease; but all animals have their peculiarities. Elephants are subject to many diseases, the most common and fatal of which is rheumatism. Monkeys and baboons generally die from bronchial affections and heart-disease, and suffer much from typhoid fever. Animals of the feline race are most subject to dysentery and heart-disease; and their prey, deer, antelopes, etc., are most liable to the same afflictions. Animals of the canine tribe are the healthiest, but too many wolves must not be kept together, or they will eat one another.

Dr. R. W. Shufeldt believes that the veterinary staff of our army needs improvement, and has suggested a plan for its reorganization, with a corps of officers carefully chosen. Thus properly organized, it could form an invaluable nucleus on which to build in time of war; in time of peace could do service to science by making comparative studies in diseases and injuries among all the domesticated animals; could more fully develop the morphology and physiology of our mammalian fauna—a work in which there is need for immediate action before some of the types shall become extinct.

In a paper on "Indicative Plants," Dr. R. W. Raymond considers a connection which is reported to exist between certain plants and the metallic contents of the soil on which they grow. Among the instances cited are the zinc violet (*Viola calaminaria*), of the Calamine Hills of Rhenish Prussia and Belgium; the lead-plant (*Amorpha canescens*), believed by American miners to grow only in localities containing galena; and the silver-plant (*Eriogonum ovalifolium*), which is regarded as a sign of silver-ores. The theories on this subject, if there be any, still lack the essential elements of verification.

General Prjevalsky is to be presented by the Imperial Scientific Society of St. Petersburg with a gold medal which has been specially struck in his honor by order of the emperor. It bears on the obverse the initials of the recipient, and on the reverse the inscription, "To the first student of the natural history of Central Asia."

Indian botanists report upon a plant which has the singular property of destroying the taste of sweetness. It is an asclepiad, and is called *Gymnema sylvestre*. After chewing a few of the leaves for a short time, if sugar be taken, the palate is found to have become insensible to all of its peculiar qualities, and it will have no more taste than sand. General Ellis has found that the *Gymnema* has also the property of abolishing the power of enjoying a cigar. It also destroys the bitter taste of quinine; but it does not affect pungent and saline things, astringents, and acids. The peculiar property of the leaves is dissolved out by alcohol, and appears to reside in an acid which is called *gymnemic* acid.

The Swedish count, M. Björnstjerna, suggested more than forty years ago, in a book on "The Theogony of the Hindoos," that, as both poles must have been cooled to a suitable temperature at the same time, the earth might have been peopled from the north pole with its white races, and from the south pole with its colored races.

Observations made at the late South Kensington Aquarium upon the effect of temperature on fish, show that the dogfish, mullet, conger, skate, flounder, bass, cod, trout, catfish, pike, and carp are extremely hardy, and can exist in a temperature ranging from 34° to 71°. The gurnard, wrasse, bull-head, sole, bream, cray-fish, blennie, perch, dace, tench, minnow, chub, roach, and gudgeon are sensitive to extremes of temperature.

Dr. Orme Masson, of the University of Melbourne, takes a hopeful view of the prospects of chemistry in Australia. The university expects soon to have well-equipped laboratories for the practical instruction of classes of medical students and for the accommodation of specialists.

The military doctors account for the prevalence of diseases of the heart in the French army as arising from the fatiguing duties imposed on recruits, at an age when, generally, the development of the body is not in harmony with that of the heart, but either in advance of it or behind it. In the latter case, there is hypertrophy of growth; in the former, insufficiency.

Mr. Goschen, British Chancellor of the Exchequer, recently assured a deputation of local university colleges that the subject of further developing technical and scientific education would receive the most serious attention of the Government.

Mr. T. P. White, in a communication to the Chemical Society, gives a decidedly negative answer to the question whether the acids of canned fruits may not form poisonous salts with the tin. He reports, as the result of his experiments, that "tin is entirely devoid of danger when taken internally in any form that might arise from being in contact with fruits or vegetables." He believes that the cases of accidental poisoning attributed to tin were due to solder or other impurities—arsenic, copper, or lead. Professor W. Mattieu Williams says that there need be no lead in the solder—that it is only put in for cheapness' sake, and that tin makes a superior solder to any alloy. Therefore, all danger may be obviated by prohibiting the use of any other solder than pure tin.

Professor Chevreul, on the 31st of August, which was his one hundred and second birthday, in perfect health, attended a meeting of the Agricultural Society and made a pleasant speech, thanking his colleagues for a bouquet which they had presented to him.

The President has appointed Professor G. Brown Goode to succeed Professor Baird, deceased, as United States Commissioner of Fish and Fisheries.

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## OBITUARY NOTES.

Alvan Clark, the famous telescope-maker, died in Cambridge, Massachusetts, August 19th, in the eighty-fourth year of his age. He was born in 1804, was taught in the public schools only; having a taste for painting and engraving, he became a calico-engraver at Lowell and elsewhere; then worked as a portrait-painter for twenty years; took up the making of telescope-lenses in 1846, and, without any other instruction than his own shop afforded, rose to unquestioned pre-eminence in that profession. He was the maker of some of the largest telescopes in the world, including the McCormick telescope at Chicago, the great instruments at Princeton and Washington, the telescope at Pulkowa, Russia, and the Lick telescope, of California.

Spencer F. Baird, head of the Smithsonian Institution and of the United States Fish Commission, died at Wood's Holl, Massachusetts, August 19th, in the sixty-fourth year of his age. He began making a collection of birds when fourteen years old, and contributed papers to the Philadelphia Academy of Sciences while still a youth; was graduated from Dickinson College when seventeen; studied medicine, but did not go into practice; became Professor of Natural History in Dickinson College in 1845; projected a work with Agassiz, which was not completed, on the fresh-water fishes of the United States; was elected Assistant Secretary of the Smithsonian Institution in 1850; was promoted to the head of that institution on the death of Professor Henry; and was appointed Commissioner of Fish and Fisheries in 1871. A list of his works and published contributions in 1882 contained more than one thousand titles.

M. Alfred Terquem, Professor of Physics at Lille, died in Paris, July 17th, in the fifty-seventh year of his age. He was a son of the eminent geologist, Terquem, also deceased.

August Friedrich Pott, who is associated by Professor Max Müller, with Bopp and Grimm, as "the triumvirs who founded the science of comparative philology," died at Halle on the 5th of July, in his eighty-fifth year. He was connected with the University of Halle during his entire active life, and was the author of "Etymologische Forschungen" and of works on the gypsies, on personal names, and on numerals, of essays on mythology, African languages, and general grammar, and of other books and papers.

Sir Walter Elliot, of the Indian Civil Service, who died recently in the eighty-fifth year of his age, was distinguished for his archæological and numismatic researches, and also for his contributions to zoölogy, a large number of which appear in the names of other naturalists, to whom he communicated them. His "Catalogue of the Species of Mammalia found in the Southern Mahratta Country" was a list of the wild animals of the country, many of which were discovered by him. The habits of the larger animals were described from personal observation.

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