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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XII. MIRACLES AND MEDICINE.

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PART I.

NOTHING in the evolution of human thought appears more inevitable than the idea of supernatural intervention in producing and curing disease. The causes of disease are so intricate that they are reached only after ages of scientific labor. In those periods when man sees everywhere miracle and nowhere law; when he attributes all things which he can not understand to a will like his own, he naturally ascribes his diseases either to the wrath of a good being or to the malice of an evil being.

This idea underlies that connection of the priestly class with the healing of diseases of which we have survivals among rude tribes in all parts of the world, and which is seen in nearly every ancient civilization—especially in the powers over disease claimed in Egypt by the priests of Osiris and Isis, in Greece by the priests of Æsculapius, and in Judea by the priests and prophets of Jahveh.

In Egypt there is evidence reaching back to a very early period that the sick were often regarded as afflicted or possessed by demons; the same belief comes constantly before us in both the great religions of India, in those of China, and it is especially elaborated in Persia. As to the Jews, the Old Testament, so precious in showing the evolution of religious and moral truth among men, attributes such diseases as the leprosy of Miriam and Uzziah, the boils of Job, the dysentery of Jehoram, the withered hand of Jeroboam, the fatal illness of Asa, and many other ills to the wrath of God or the malice of Satan; in the New Testament, such examples as the woman "bound by Satan," the rebuke of the fever, the casting out of the devil which was dumb, the healing of the person whom "the devil ofttimes casteth into the fire"—of which case one of the greatest modern physicians remarks that never was there a truer description of epilepsy—and various other examples, show this same inevitable mode of thought as a refracting medium through which the teachings and doings of the Great Physician were revealed to future generations.

The civilization of Greece alone appears to have been wholly or nearly free from this idea of the agency of demons in producing bodily ills; hence, Greece was the first of the ancient nations, and indeed the only one, so far as we know, in which a scientific idea of medicine was evolved. Five hundred years before Christ, in the great bloom period of thought, the period of Æschylus, Phidias, Pericles, Socrates, and Plato, Hippocrates appeared, and his is one of the greatest names in all history. Quietly but thoroughly he broke away from the old tradition, developed scientific thought, and laid the foundations of medical science upon experience, observation, and reason so deeply and broadly that his teaching remains to this hour among the most precious possessions of our race.

His thought was passed on to the School of Alexandria, and there medical science was developed yet further, especially by such men as Herophilus and Erasistratus. Under their lead studies in human anatomy began by dissection; the old prejudice which had weighed so long upon the human race, preventing that method of anatomical investigation without which there can be no real results, was cast aside apparently forever.*

But with the coming in of Christianity a great new chain of events was set in motion which modified most profoundly the further evolution of medical science. The influence of Christi-

* For extended statements regarding medicine in Egypt, Judea, and Eastern nations generally, see Sprengel, Histoire de la Médecine, earlier volumes; and for more succinct accounts, Baas, Geschichte der Medicin, pp. 15–29; also Isensee; also Frédault, Histoire de la Médecine, chap. i. For the effort in Egyptian medicine to deal with demons and witches, see Heinrich Brugsch, Die Aegyptologie, Leipsic, 1891, p. 77; and for references to the Papyrus Ebers, etc., pp. 155, 407, and following. For the derivation of priestly medicine in Egypt, see Baas, p. 22. For the fame of Egyptian medicine at Rome, see Sharpe, History of Egypt, vol. ii, pp. 151 and 184. On the cheapness and commonness of miracles of healing in antiquity, see Sharpe, quoting St. Jerome, vol. ii, pp. 137, 191. As to the freedom of ancient Greece from the idea of demoniacal intervention in disease, see Lecky, History of European Morals, vol. i, p. 404 and note. For the evolution of medicine before and after Hippocrates, see Sprengel, p. 1283 and following. For a good summing up of the work of Hippocrates, see Baas, p. 201. For the necessary passage of medicine in its early stages under priestly control, see Cabanis, The Revolutions of Medical Science, London, 1806, chap. ii. On Jewish ideas regarding demons, and their relation to sickness, see Toy, Judaism and Christianity, Boston, 1891, pp. 168 *et seq.* For Herophilus, Erasistratus, and the School of Alexandria, see Sprengel, vol. i, pp. 433, 434 *et seq.*

anity on the healing art was twofold; there was first a blessed impulse—the thought, aspiration, example, ideals, and spirit of Jesus of Nazareth. This spirit, then poured into the world, flowed down through the ages, promoting self-sacrifice for the sick and wretched. Through all those succeeding centuries, even through the rudest, hospitals and infirmaries sprang up along this blessed stream. Of these were the Eastern establishments for the cure of the sick at the earliest Christian periods; the Infirmary of Monte Casino in the fifth century, the Hôtel-Dieu at Lyons in the sixth, the Hôtel-Dieu at Paris in the seventh, and the myriad refuges for the sick and suffering which sprang up in every part of Europe during the following centuries. Vitalized by this stream, all conceivable growths of mercy bloomed forth. To say nothing of those at an earlier period, we have in the time of the Crusades great charitable organizations like the Order of St. John of Jerusalem, and thenceforward every means of bringing the spirit of Jesus to help afflicted humanity. So, too, through all those ages we have a succession of men and women devoting themselves to works of mercy, culminating during modern times in saints like Vincent de Paul, Francke, Howard, Florence Nightingale, Elizabeth Fry, and Muhlenberg.

But while this vast influence, poured forth from the heart of the founder of Christianity, streamed through century after century, inspiring every development of mercy, there came from those who organized the Church which bears his name, and from those who afterward developed and directed it, another stream of influence—a theology drawn partly from prehistoric conceptions of unseen powers, partly from ideas developed in the earliest historic nations, but especially from the letter of the Hebrew and Christian sacred books.

The theology developed out of our sacred literature in relation to the cure of disease was mainly twofold: first, there was a new and strong evolution of the old idea that physical disease is produced by the wrath of God or the malice of Satan, or by a combination of both, which theology was especially called in to explain; secondly, there were evolved theories of miraculous methods of cure, based upon modes of staying the divine anger, or of thwarting Satanic malice.

Along both these streams of influence, one arising in the life of Jesus, and the other in the reasonings of theologians, legends of miracles grew luxuriantly. It would be utterly unphilosophical to attribute these as a whole to conscious fraud; whatever part priestcraft may have taken afterward in sundry discreditable developments of them, the mass of miraculous legends, century after century, grew up mainly in good faith, and as naturally as elms along water-courses or flowers upon the prairie.

Legends of miracles have thus grown about the lives of all great benefactors of humanity in early ages, and about saints and devotees. Throughout human history the lives of such personages, almost without exception, have been accompanied or followed by a literature in which legends of miraculous powers form a very important part—a part constantly increasing until a different mode of looking at Nature and of weighing testimony causes miracles to disappear. While modern thought holds the testimony to the great mass of such legends in all ages as worthless, it is very widely acknowledged that great and gifted beings who endow the earth with higher religious ideas, gaining the deepest hold upon the hearts and minds of multitudes, may at times exercise such influence upon those about them that the sick in mind or body are helped or healed.

We have within the modern period very many examples which enable us to study the evolution of legendary miracles, and among the most instructive of them all is the life of St. Francis Xavier. One of the noblest characters in the sixteenth century, he sacrificed the brilliant career which he had begun at Paris, and gave himself entirely to missionary work in the far East. Among the various tribes of lower India and afterward in Japan he wrought untiringly, toiling through village after village, collecting the natives by the sound of a hand-bell, trying to teach them the simplest Christian formulas, and thus he brought myriads of them to a nominal confession of the Christian faith. After twelve years of such efforts, seeking new conquests for religion, he sacrificed his life on the desert island of San Chan.

During his career as a missionary he wrote great numbers of letters which were preserved and have since been published; these and the letters of his contemporaries exhibit clearly all the features of his life. His own writings are very minute, and enable us to follow him and his doings fully. No account of a miracle wrought by him appears either in his own letters or in any contemporary document. At the outside but two or three things occurred in his whole life, as exhibited so fully by himself and his contemporaries, for which the most earnest devotee could claim anything like divine interposition; and these are such as may be read in the letters of nearly all fervent missionaries, Protestant as well as Catholic. For example, in the beginning of his career, during a journey in Europe with an ambassador, one of the servants in fording a stream got into deep water and was in danger of drowning. Xavier tells us that the ambassador prayed very earnestly, and that the man finally struggled out of the stream. But within sixty years after his death, at his canonization, and by various biographers, this had been magnified into a miracle, and appears in the various histories dressed out in glowing colors.

Xavier tells us that the ambassador prayed for the safety of the young man, but the biographers tell us that it was Xavier who prayed; and finally, by the later writers Xavier is represented as lifting horse and rider out of the stream by a clearly supernatural act.

Still another claim to miracle is based upon his arrival at Lisbon and finding his great colleague, Simon Rodriguez, ill of fever. Xavier informs us in a very simple way that Rodriguez was so overjoyed to see him that the fever did not return. This is entirely similar to the cure which Martin Luther wrought upon Melanchthon. Melanchthon had broken down and was supposed to be dying, when his joy at the long-delayed visit of Luther brought him to his feet again, after which he lived for many years. Finally, Xavier, finding a poor native woman very ill, baptized her, saying over her the prayers of the Church, and she recovered.

Two or three occurrences like these form the whole basis for the miraculous accounts, so far as Xavier's own writings are concerned.

But shortly after Xavier's death in 1552 miracles of a different sort began to appear. At first they were few and feeble; and two years later Melchior Nunhez, Provincial of the Jesuits in the Portuguese dominions, with all the means at his command, and a correspondence extending throughout all those regions, had been able to hear of but three. These were entirely from hearsay. First, John Deyro said he knew Xavier had the gift of prophecy; but, unfortunately, Xavier himself had reprimanded and cast off Deyro for untruthfulness and cheatery. Secondly, at Cape Comorin many persons affirmed that Xavier had raised a dead person. Thirdly, Father Pablo de Santa Fé said that in Japan Xavier had restored sight to a blind man. This seems a feeble beginning, but little by little the stories grew; and in 1555 De Quadros, Provincial of the Jesuits in Ethiopia, had heard of nine miracles, and laid stress upon the fact that Xavier had healed the sick and cast out devils. The next year, being four years after Xavier's death, King John III of Portugal, a very devout man, in a letter, taking these wonderful works in all parts of the East for granted, directed his viceroy, Barreto, to draw up and transmit to him an authentic account of Xavier's miracles; urging him especially to do the work "with zeal and speedily." We can well imagine what treasures of grace an obsequious viceroy, only too anxious to please a devout king, could bring together by means of the hearsay of ignorant, compliant natives through all the little towns of Portuguese India.

A vast mass of testimony was thus brought together and taken to Rome; but it appears to have been thought of but little value by those best able to judge, for when, in 1588, thirty-six years after Xavier's death, the Jesuit father Maffei, who had been especially conversant with Xavier's career in the East, published his History of India, though he gave a biography of Xavier which shows fervent admiration for his subject, he dwelt very lightly on the alleged miracles. But six years later, in 1594, Father Tursellinus published his Life of Xavier, and in this appears to have made the first large use of the information collected by the Portuguese viceroy. This work shows a vast increase in the number of miracles over those given by all sources together up to that time. Xavier is represented as not only curing the sick, but casting out devils, stilling the tempest, raising the dead, and performing miracles of every sort.

In 1622 came the canonization proceedings at Rome. Among the speeches made in the presence of Pope Gregory XV, supporting the claims of Xavier to saintship, the most important was by Cardinal Monte. In this the orator selects out ten great miracles from those performed by Xavier during his lifetime and describes them minutely. He insists that on a certain occasion Xavier, by the sign of the cross, made sea-water fresh so that his fellow-passengers and the crew could drink it; that he healed the sick and raised the dead in various places, brought back a lost boat to his ship, was on one occasion lifted from the earth bodily and transfigured before the bystanders; and that, to punish a blaspheming town, he caused an earthquake and buried the offenders in cinders from a volcano: this was afterward still more highly developed, and the saint was represented in engravings as calling down fire from heaven and thus destroying the town.

The most curious miracle of all is the eighth on the cardinal's list. Regarding this he states that Xavier having during one of his voyages lost overboard a crucifix, it was restored to him after he had reached the shore by a crab.

The cardinal also dwelt on miracles performed by Xavier's relics after his death, the most original being that sundry lamps placed before the image of the saint and filled with holy water burned as if filled with oil.

This latter account appears to have deeply impressed the Pope, for in the Bull of Canonization issued by virtue of his power of teaching the universal Church infallibly in faith and morals, his Holiness dwells especially upon the miracle of the lamp filled with holy water and burning before Xavier's image.

Xavier having been made a saint, many other Lives of him appeared, and, as a rule, each surpassed its predecessor in the multitude of miracles. In 1622 appeared that by Father Vitelleschi, and in it not only are the miracles increased, but some old ones are greatly improved. One example will suffice to show the process. In his edition of 1596, Tursellinus had told a story how

Xavier, one day needing money, asked Vellio, one of his friends, to let him have some. Vellio gave him the key of a safe containing thirty thousand gold pieces. Xavier took three hundred and returned the key to Vellio, telling him what he had taken. At this Vellio reproached Xavier for not taking more, saying that he had expected to give him half of all that the strong-box contained. Xavier, touched by this generosity, told Vellio that the time of his death should be made known to him, that he might have time to repent of any sins and prepare for eternity. But twenty-six years later, Vitelleschi, in his Life of Xavier, telling the story, says that Vellio on opening the safe found that all his money remained as he had left it, and that none at all had disappeared; in fact, that there had been a miraculous restoration. On his blaming Xavier for not taking the money, Xavier declares to Vellio that not only should he be apprised of the moment of his death, but that he should always have all the money he needed. Still later biographers improved the account further, declaring that Xavier promised Vellio that the strong-box should always contain money sufficient for his needs.

In 1682, one hundred and thirty years after Xavier's death, appeared his biography by Father Bouhours; and this became a classic. In it miracles of all kinds were enormously multiplied, and many new ones given. Miracles few and small in Tursellinus are many and great in Bouhours, and among the new ones is a miraculous draught of fishes. It must be remembered that Bouhours, writing ninety years after Tursellinus, could hardly have had access to any really new sources; Xavier had been dead one hundred and thirty years, and of course all the natives upon whom he had wrought his miracles, and their children and grandchildren, were gone. It can not then be claimed that Bouhours had the advantage of any new witnesses, nor could he have had anything new in the way of contemporary writings; for, as we have seen, the missionaries of Xavier's time wrote nothing regarding his miracles, and certainly the ignorant natives of India and Japan did not commit any account of his miracles to writing. Nevertheless, the miracles of healing given in Bouhours were more numerous and brilliant than ever. But there was far more than this. Although during the lifetime of Xavier there is, neither in his own writings nor in any contemporary account the least indication of resurrections from the dead, we find that shortly after his death stories of resurrections wrought by him during his lifetime began to appear. A simple statement of the growth of these may throw some light on the evolution of miraculous accounts generally. At first it was affirmed that some people at Cape Comorin said that he resuscitated one person; then it was said that there were two persons; then in various authors, Acosta, De Quadros, and others, the story wavers between one and two cases; finally, in the time of Tursellinus, four cases had been developed. In 1622, at the canonization proceedings, three were mentioned; but, by the time of Father Bouhours, there were twenty-five.

It seems to have been felt as somewhat strange at first that Xavier had never alluded to any of these wonderful miracles; but ere long a subsidiary legend was developed, to the effect that one of the brethren asked him one day if he had raised the dead, whereat he blushed deeply and cried out against the idea, saying: "And so I am said to have raised the dead! What a misleading man I am! Some men brought a youth to me just as if he were dead, who, when I commanded him to arise in the name of Christ, straightway arose."

Noteworthy is the evolution of other miracles: Tursellinus, writing in 1594, tells us that on the voyage from Goa to Malacca, Xavier having left the ship and gone upon an island, was afterward found by the persons sent in search of him so deeply absorbed in prayer as to be unmindful of all things about him. But in the next century Father Bouhours develops the story as follows: "The servants found the man of God raised from the ground into the air, his eyes fixed upon heaven, and rays of light about his countenance."

Instructive, also, is a comparison between the accounts of his great miracle among the Badages at Travancore in 1544. In Xavier's letters he makes no reference to anything extraordinary; but Acosta, in 1573, declares that "Xavier threw himself into the midst of the Christians, that reverencing him they might spare the rest." The inevitable evolution of this matter goes on; and after twenty years Tursellinus tells us that at the onslaught of the Badages, "they could not endure the majesty of his countenance and the splendor and rays which issued from his eyes, and out of reverence for him they spared the others." The process of incubation still goes on during ninety years more, and then we have Bouhours's account: having given Xavier's prayer on the battle-field, Bouhours goes on to say that the saint, crucifix in hand, rushed at the head of the people toward the plain where the enemy was marching, and "said to them in a threatening voice, 'I forbid you in the name of the living God to advance further, and on his part command you to return in the way you came.' These few words cast a terror into the minds of those soldiers who were at the head of the army; they remained confounded and without motion. They who marched afterward, seeing that the foremost did not advance, asked the reason of it; the answer was returned from the front ranks that they had before their eyes an unknown person habited in black, of more than human stature, of terrible aspect, and darting fire from his eyes. . . . They were seized with amazement at the sight, and all of them fled in precipitate confusion."

Curious, too, is the after-growth of the miracle of the crab restoring the crucifix. In its first form Xavier lost the crucifix in the sea, and the earlier biographers dwell on the sorrow which he showed in consequence; but the later historians declare that the saint threw the crucifix into the sea in order to still a tempest. In this form we find it among illustrations of books of devotion in the next century.

But perhaps the best illustration of this evolution of miracles in Xavier's case is to be found in the growth of another legend; and it is especially instructive because it grew luxuriantly despite the fact that it was utterly contradicted in all parts of Xavier's writings.

Throughout his letters, from first to last, Xavier constantly dwells upon his difficulties with the various languages of the different tribes among whom he went. He tells us how he surmounted these difficulties: sometimes by learning just enough of a language to translate into it some of the main Church formulas; sometimes by getting the help of others to patch together some pious teachings to be learned by rote; sometimes by employing interpreters; and sometimes by a mixture of various dialects and by signs. On one occasion he tells us that a very serious difficulty arose, and that his voyage to China was delayed because, among other things, the interpreter he had engaged had failed to meet him.

In various Lives which appeared between the time of his death and his canonization, this difficulty is much dwelt upon; but during the canonization proceedings at Rome, in the great speeches then made, and finally in the papal bull, great stress was laid upon the fact that Xavier possessed the gift of tongues. It was declared that he spoke to the various tribes with ease in their own languages. This legend of Xavier's miraculous gift of tongues was especially mentioned in the papal bull, and was solemnly given forth by the pontiff as an infallible statement to be believed by the universal Church. Gregory XV having been prevented by death from issuing the Bull of Canonization, it was finally issued by Urban VIII. To a thinking man there is much food for reflection in the fact that the same pope who punished Galileo, and was determined that the Inquisition should not allow the world to believe that the earth revolves about the sun, thus solemnly ordered the world, under pain of damnation, to believe in Xavier's miracles, including his "gift of tongues," and the return of the crucifix by the pious crab. But the legend was developed still further: Father Bouhours tells us, "The holy man spoke very well the language of those barbarians without having learned it, and had no need of an interpreter when he instructed." And, finally, in our own time, the Rev. Father Coleridge, speaking of the saint among the natives, says, "He could speak the language excellently, though he had never learned it."

In the early biography, Tursellinus writes: "Nothing was a greater impediment to him than his ignorance of the Japanese tongues; for, ever and anon, when some uncouth expression offended their fastidious and delicate ears, the awkward speech of Francis was a cause of laughter." But Father Bouhours, a century later, writing of Xavier at the same period, says, "He preached in the afternoon to the Japanese in their language, but so naturally and with so much ease that he could not be taken for a foreigner."

And finally, in 1872, Father Coleridge, of the Society of Jesus, speaking of Xavier at this time, says, "He spoke freely, flowingly, elegantly, as if he had lived in Japan all his life."

Nor was even this sufficient: to make the legend complete, it was declared that, when Xavier addressed the natives of various tribes, each heard the sermon in his own language in which he was born.*

It is hardly necessary to attribute to the orators and biographers generally a conscious attempt to deceive. The simple fact is, that as a rule they thought, spoke, and wrote in obedience to the natural laws which govern the luxuriant growth of myth and legend in the warm atmosphere of love and devotion which constantly arises about great religious leaders in times when men have little or no knowledge of natural law, when there is little care for scientific evidence, and when he who believes most is thought most meritorious.

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* For the evolution of the miracles of Xavier, see his Letters with Life, published by Léon Pagès, Paris, 1855. Also, Maffei, Historiarum Indicarum, Libri xvi, Venice, 1589. Also the Lives by Tursellinus, various editions, beginning with that of 1596; Vitelleschi, 1622; Bouhours, 1682; Massei, second edition, 1682 (Rome), and others; Fabers Bartoli, Baltimore, 1868; Coleridge, 1872. In addition to these, I have compared, for a more extended discussion of this subject hereafter, a very great number of editions of these and other biographies of the saint with speeches at the canonization, the Bull of Gregory XIII, various books of devotion, and a multitude of special writings, some of them in manuscript, upon the glories of the saint. The illustration of the miracle of the crucifix and crab in its final form is given in La Dévotion de Dix Vendredis à l'Honneur de St. François Xavier, Bruxelles, 1699, Fig. 24. For the letter of King John to Barreto see Léon Pagès's Lettres de St. François Xavier, Paris, 1855, vol. ii, p. 465. For the miracle among the Badages, compare Tursellin. lib. ii, c. x, p. 16, with Bouhours, Dryden's translation, pp. 146, 147. For miracle of the gift of tongues, in its higher development, see Bouhours, p. 143, and Coleridge, vol. i, pp 172 and 208; and as to Xavier's own account see Coleridge, vol. i, pp. 151, 154, and vol. ii, 551.

These examples will serve to illustrate the process which in thousands of cases has gone on from the earliest days of the Church until a very recent period. Everywhere miraculous cures became the rule rather than the exception throughout Christendom.

So it was that, throughout antiquity, during the early history of the Church, throughout the middle ages, and indeed down to a comparatively recent period, testimony to miraculous interpositions which would now be laughed at by a school-boy was accepted by the leaders of thought. St. Augustine was certainly one of the strongest minds in the early Church, and yet we find him mentioning, with much seriousness, a story that sundry innkeepers of his time put a drug into cheese which metamorphosed travelers into domestic animals. With such a disposition regarding the wildest stories, it is not surprising that the assertion of St. Gregory of Nazianzen, during the second century, as to the cures wrought by the martyrs Cosmo and Damian, was echoed from all parts of Europe until every hamlet had its miracle-working saint or relic.

The literature regarding these miracles is simply endless. To take our own ancestors alone, no one can read the Ecclesiastical History of Bede, or Abbot Samson's Miracles of St. Edmund, or the accounts given by Eadmer and Osberne of the miracles of St. Dunstan, or the long lists of those wrought by Thomas à Becket, or by any other in the army of English saints, without seeing the perfect naturalness of this growth. This evolution of miracle in all parts of Europe came out of a vast preceding series of beliefs, extending not merely through the early Church, but far back into paganism. Just as formerly people were cured in the temples of Æsculapius, so now they were cured at the shrines of saints. Moreover, the miracles of the sacred books were taken as models, and each of those given by the sacred chroniclers was repeated during the early ages of the Church and through the mediæval period with endless variations of circumstance, but still with curious fidelity to the original type.

It should be especially kept in mind that, while the vast majority of these were doubtless due to the myth-making faculty and to that development of legends which always goes on in ages ignorant of the relation between physical causes and effects, some of the miracles of healing may have had some basis in fact. We, in modern times, have seen too many cures performed through influences exercised upon the imagination, such as those of the Jansenists at the Cemetery of St. Médard, of the Ultramontanes at La Salette and Lourdes, and of various Protestant sects at Old Orchard and elsewhere, as well as at sundry camp-meetings, to doubt that some cures, more or less permanent, were wrought by sainted personages in the early Church and throughout the middle ages.*

But miraculous cures were not ascribed to persons merely. Another growth, mainly from germs in our sacred books developed by the early Church, took shape in miracles wrought by streams, by pools of water, and especially by relics. Here, too, the old types persisted, and just as we find holy and healing wells, pools, and streams in all other ancient religions, so we find in the evolution of our own such examples as Naaman the Syrian cured of leprosy by bathing in the river Jordan, the blind man restored to sight by washing in the pool of Siloam, and the healing of those who touched the bones of Elisha, the shadow of St. Peter, or the handkerchief of St. Paul.

St. Cyril, St. Ambrose, St. Augustine, and other great fathers of the early Church sanctioned the belief that similar efficacy was to be found in the relics of the saints of their time; hence, St. Ambrose declared that "the precepts of medicine are contrary to celestial science, watching, and prayer"; and we find this statement reiterated from time to time throughout the middle ages. From this idea was evolved that fetichism which we shall see for ages standing in the way of medical science.

Theology, developed in accordance with this idea, wrapped all scientific effort more and more in an atmosphere of supernaturalism. The vividness with which the accounts of miracles in the sacred books were realized in the early Church continued the idea of miraculous intervention throughout the middle ages. The

* For the story of travelers converted into domestic animals, see St. Augustine, De Civ. Dei, liber xviii, chaps. xvii, xviii, in Migne, tom. xli, p. 574. For Gregory of Nazianzen and the similarity of these Christian cures in general character to those wrought in the temples of Æsculapius, see Sprengel, vol. ii, pp. 145, 146. For the miracles wrought at the shrine of St. Edmund, see Samsonis Abbatis Opus de Miraculis Sancti Ædmundi, in the Master of the Rolls series, *passim*, but especially chaps. xiv and xix, for miracles of healing wrought on those who drank out of the saint's cup. For the mighty works of St. Dunstan, see the Mirac. Sanct Dunstan, Auctore Eadmero and Auctore Osberno, in the Master of the Rolls series. As to Becket, see the materials for the Life of Thomas à Becket in the same series, and especially the lists of miracles—the mere index of them in the first volume requires thirteen octavo pages. For St. Martin of Tours, see the Guizot edition of French Chronicles. For miracle and shrine cures chronicled by Bede, see his Ecclesiastical History, *passim*, but especially from page 110 to page 267. For similarity between the ancient custom of allowing invalids to sleep in the temples of Serapis and the mediæval custom of having them sleep in the church of St. Antony of Padua and other churches, see Meyer, Aberglaube des Mittelalters, Basel, 1884, chap. iv. For the effect of "the vivid belief in supernatural action which attaches itself to the tombs of the saints," etc., as "a psychic agent of great value," see Littré, Médecine et Médecins, p. 131. For the Jansenist miracles at Paris, see La Vérité des Miracles opérés par l'Intercession de M. de Paris, par Montgéron, Utrecht, 1737, and especially the cases of Mary Anne Couronneau, Philippe Sergent, and Gautier de Pezenas. For some very thoughtful remarks as to the worthlessness of the testimony to miracles presented during the canonization proceedings at Rome, see Maury, Légendes Pieuses.

testimony of the great fathers of the Church to the continuance of miracles is overwhelming; but everything shows that they so fully expected miracles on the slightest occasion as to require nothing which in these days would be regarded as adequate evidence.

In this atmosphere of theologic thought, medical science was at once checked. The School of Alexandria, under the influence first of Jews and later on of Christians, both permeated with Oriental ideas, and taking into their theory of medicine demons and miracles, soon enveloped everything in mysticism. In the Byzantine Empire of the East the same cause produced the same effect: the evolution of ascertained truth in medicine begun by Hippocrates and continued by Herophilus, seemed lost forever. Medical science, trying to move forward, was like a ship becalmed in the Sargasso Sea: both the atmosphere about it and the medium through which its progress must be made resisted all movement. Instead of reliance upon observation, experience, experiment, and thought, attention was turned toward supernatural agencies.*

Especially prejudicial to a true development of medical science among the first Christians was their attribution of disease to diabolic possession. St. Paul had distinctly declared that the gods of the heathen were devils; and everywhere the early Christians saw in disease the malignant work of these dethroned powers of evil. The Gnostic and Manichæan struggles had ripened the theologic idea that at times diseases are punishments by the Almighty, but that the main agency in them is Satanic. The great fathers and renowned leaders of the early Church accepted and strengthened this idea. Origen says: "It is demons which produce famine, unfruitfulness, corruptions of the air, pestilences; they hover concealed in clouds in the lower atmosphere and are attracted by the blood and incense which the heathen offer to them as gods." St. Augustine says: "All diseases of Christians are to be ascribed to these demons; chiefly do they torment fresh-baptized Christians, yea, even the guiltless, new-born infants." Tertullian insists that a malevolent angel is in constant attendance upon every person. Gregory of Nazianzen declares that bodily pains are provoked by demons, and that medicines are useless, but that they are often cured by the laying on of consecrated hands. St. Nilus and St. Gregory of Tours, echoing St. Ambrose, give examples to show the sinfulness of resorting to medicine instead of trusting to the intercession of saints. Leaders of the Church very gener-

* For the mysticism which gradually enveloped the School of Alexandria, see Barthélemy Saint-Hilaire, De l'École d'Alexandrie, Paris, 1845, vol. vi, p. 161. For the effect of the new doctrines on the Empire of the East, see Sprengel, vol. ii, p. 240. As to the more common miracles of healing and the acknowledgment of non-Christian miracles of healing by Christian fathers, see Fort, p. 84.

ally scouted the theory that diseases are due to natural causes, and most of them deprecated a resort to surgeons and physicians rather than to supernatural means.*

Other considerations were developed as the middle ages went on which strengthened this idea. Again we must bear in mind that while there is no need to attribute the mass of these stories regarding miraculous cures to conscious fraud, there was, without doubt, at a later period, no small admixture of belief biased by self-interest, with much pious invention and suppression of facts. Enormous revenues flowed into various monasteries and churches in all parts of Europe from relics noted for their healing powers. Every cathedral, every great abbey, and nearly every parish church claimed possession of healing relics. While, undoubtedly, a childlike faith was at the bottom of this belief, there came out of it unquestionably a great development of the mercantile spirit. The commercial value of sundry relics was often very high. In the year 1056 a French ruler pledged securities to the amount of ten thousand solidi for the production of the relics of St. Just and St. Pastor, pending a legal decision regarding the ownership between him and the Archbishop of Narbonne. The Emperor of Germany on one occasion demanded, as a sufficient pledge for the establishment of a city market, the arm of St. George. The body of St. Sebastian brought enormous wealth to the Abbey of Soissons; Rome, Canterbury, Treves, Marburg, every great city drew large revenues from similar sources, and the Venetian Republic ventured very considerable sums in the purchase of relics.

Naturally, then, the corporations, whether lay or ecclesiastical, which drew large revenue from relics looked with little favor on a science which tended to discredit their investments.

Nowhere perhaps in Europe can the philosophy of this development of fetichism be better studied than at Cologne. At the cathedral, preserved in a magnificent shrine since about the twelfth century, are the skulls of the Three Kings or Wise Men of the East, who, guided by the star of Bethlehem, brought incense to the Saviour. These relics were an enormous source of wealth to the cathedral chapter during many centuries. But other ecclesiastical bodies in that city were both pious and shrewd, and so we find that not far off, at the church of St. Gereon, a cemetery has been dug up, and the bones distributed over the

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* For Origen, see the Contra Celsum, lib. vii, chap. 31. For Augustine, De Divinit. et Demon., chap. iii, p. 371. For Tertullian and Gregory of Nazianzen, see citations in Sprengel and in Fort, p. 6. For Gregory of Tours and St. Nilus, see History of France, vol. v, p. 6; De Mirac. S. Martini, vol. ii, p. 60; cited in the History of the Inquisition of the Middle Ages, by Henry Charles Lea, New York, 1888, p. 410, note. For the turning of the Greek mythology into a demonology as largely due to St. Paul, see I Corithians, chap. x, v. 20: "The things which the Gentiles sacrifice, they sacrifice to devils and not to God."

walls as the relics of St. Gereon and his Theban band of martyrs! Again, at the neighboring church of St. Ursula, we have the later spoils of another cemetery, covering the interior walls of the church as the bones of St. Ursula and her eleven thousand virgin martyrs: the fact that anatomists now declare many of them to be the bones of men does not appear in the middle ages to have diminished their power of competing with the relics at the other shrines in healing efficiency.

Other developments of fetich cure were no less discouraging to the evolution of medical science. Very important among these was the Agnus Dei, or piece of wax from the Paschal candles stamped with the figure of a lamb, and consecrated by the pope. As late as 1471 Pope Paul II expatiated to the Church on the efficacy of this fetich in preserving men from fire, shipwreck, tempest, lightning, and hail, and in assisting women in childbirth; and he reserved to himself and his successors the manufacture of it.

Naturally the frame of mind thus stimulated created a necessity for amulets and charms of other kinds; and under this influence we find a reversion to old pagan fetiches: nothing on the whole stood more constantly in the way of any proper development of medical science than these fetich cures, whose efficacy was based on theological modes of reasoning.

It would be expecting too much from human nature to imagine that pontiffs who derived large revenues from the sale of the Agnus Dei, or that priests who derived both wealth and honors from cures wrought at shrines under their care, or that lay dignitaries who had invested heavily in relics should favor the development of any science which undermined their interests.* Moreover, other developments of thought in the Church were hardly less fatal to the evolution of medical science.

First of these was a wide-spread Egyptian and Oriental theory, mainly transmitted through the Jewish sacred books, of the unlawfulness of meddling with the bodies of the dead. And when to this was added the mysterious idea of the human body as the temple of the Holy Ghost, and a dread of interfering with it lest some injury might result in its final resurrection at the day of judgment, there came an addition to the mysterious reasons which forbade men to pursue the study of anatomy by means of dissection. Tertullian denounced the anatomist Herophilus as a butcher; Augustine spoke of anatomists generally in similar terms. The threat of excommunication launched by Pope Boni-

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* See Fort's Medical Economy during the Middle Ages, pages 211–213; also the Handbooks of Murray and Baedeker for North Germany, and various histories of medicine *passim;* also Collin de Plancy and scores of others. For an account of the Agnus Dei, see Rydberg, pp. 62, 63.

face VIII against those guilty of dissections was simply a development of this feeling.

Still further, in spite of the fearful cruelties which the Church, when firmly established, promoted so freely against those suspected of witchcraft or heresy, there grew up a theory which took shape in the maxim that "the Church abhors the shedding of blood," and this maxim was used with deadly effect against the progress of surgery. It led to ecclesiastical mandates which withdrew from this branch of the healing art the most thoughtful and cultivated men of the middle ages, and which placed surgery in the hands of the lowest class of nomadic charlatans. So deeply was this idea thus rooted in the universal Church that for over a thousand years surgical practice was considered dishonorable; the greatest monarchs were often unable to secure an ordinary surgical operation; and it was only in 1406 that a better beginning was made, when the Emperor Wenzel of Germany ordered that dishonor should no longer attach to the surgical profession.*

In spite of all these opposing forces, the evolution of medical science continued, though but slowly. In the second century of the Christian era Galen had made himself a great authority at Rome, and from Rome had swayed the medical science of the world: his genius triumphed over the defects of his method; but, though he gave a powerful impulse to medicine, his dogmatism stood in the way of it long afterward.

The places where medicine, such as it thus became, could be applied, were at first mainly the infirmaries of various monasteries, especially the larger ones of the Benedictine Order. These were frequently developed into hospitals: many monks devoted themselves to such medical studies as were permitted, and sundry churchmen and laymen did much to secure and preserve copies of ancient medical treatises. So, too, in the cathedral schools established by Charlemagne and others, provision was generally made for medical teaching; but all this instruction, whether in convents or schools, was wretchedly poor. It consisted not in the development by individual thought and experiment of the gifts of Hippocrates, Aristotle, and Galen, but almost entirely in the parrot-like repetition of their writings.

But while the inherited ideas of church leaders were thus unfavorable to any proper development of medical science, there were two bodies of men outside the Church who, though largely fettered by superstition, were far less so than the monks and students of ecclesiastical schools: these were the Jews and the Mohammedans. The first of these especially had inherited many

* As to denunciations of surgery by the Church authorities, see Sprengel, II, 7, 8; also, Fort, pp. 452 *et seq.*; and for the reasoning which led the Church to forbid surgery to priests, see especially Frédault, Histoire de la Médecine, p. 200.

useful sanitary and hygienic ideas, which had probably been first evolved by the Egyptians, and from them transmitted to the world mainly through the sacred books attributed to Moses; and both Jews and Mohammedans, while fettered by various superstitions of their own, were far less influenced by the mediæval development of miracles than were their Christian contemporaries.

The Jewish scholars became especially devoted to medical science. To them is largely due the creation of the School of Salerno, which we find flourishing in the tenth century. Judged by our present standards, its work was poor indeed, but, compared with other medical instruction of the time, it was vastly superior: it developed hygienic principles especially, and brought medicine upon a higher plane.

Still more important is the rise of the School of Montpellier; this was due almost entirely to Jewish physicians, and it developed medical studies to a yet higher point, doing much to create a medical profession worthy of the name throughout southern Europe.

As to the Arabians, we find them from the tenth to the fourteenth century, especially in Spain, giving much thought to medicine, and to chemistry as subsidiary to it. About the beginning of the ninth century, when the greater Christian writers were supporting fetich by theology, Almamon, the Moslem, declared, "They are the elect of God, his best and most useful servants, whose lives are devoted to the improvement of their rational faculties." The influence of Avicenna, the translator of the works of Aristotle, from the beginning of the eleventh century extended throughout all Europe. The Arabians were indeed much fettered by tradition in medical science, but their translations of Hippocrates and Galen preserved to the world the best thus far developed in medicine, and still better were their contributions to pharmacy; these remain of value to the present hour.*

Various Christian laymen also rose above the prevailing theologic atmosphere far enough to see the importance of promoting scientific development. First among these we may name the Emperor Charlemagne; he and his great minister, Alcuin, not only promoted medical studies in the schools they founded, but also made provision for the establishment of botanic gardens in which

* For the great services rendered to the development of medicine by the Jews, see Monteil, Médecine en France, p. 58; also the historians of medicine generally. For the quotation from Almamon, see Gibbon, vol. x, p. 42. For the services of both Jews and Arabians, see Bédarride, Histoire des Juifs, p. 115. Also Sismondi, Histoire des Français, cited by Fort, pp. 449, 450. For Arabians, especially, see Rosseuw Saint-Hilaire, Histoire d'Espagne, Paris, 1844, vol. iii, pp. 191 *et seq.* For the tendency of the Mosaic books to insist on hygienic rather than therapeutical treatment, and its consequences among Jewish physicians, see Sprengel, but especially Frédault, p. 14.

those herbs were especially cultivated which were supposed to have healing virtues. So, too, in the thirteenth century, the Emperor Frederick II, though under the ban of the pope, brought together in his various journeys, and especially in his crusading expeditions, many Greek and Arabic manuscripts, and took special pains to have those which concerned medicine preserved and studied; he also promoted better ideas of medicine, and embodied them in law.

Men of science also rose, in the stricter sense of the word, even in the centuries under the most complete sway of theological thought and ecclesiastical power; a science, indeed, alloyed with theology, but still infolding precious germs. Of these were men like Arnold of Villanova, Bertrand de Gordon, Albert of Bollstadt, Basil Valentine, Raymond Lull, and, above all, Roger Bacon, all of whom cultivated sciences subsidiary to medicine, and in spite of charges of sorcery, and consequent imprisonment and danger of death, kept the torch of knowledge burning, and passed it on to future generations.*

From the Church itself, also, even when the theological atmosphere was most dense, rose here and there men who persisted in something like scientific effort. As early as the ninth century, Bertrarius, a monk of Monte Casino, prepared two manuscript volumes of prescriptions selected from ancient writers; other monks studied them somewhat, and during succeeding ages, scholars like Hugo, Abbot of St. Denis; Sigoal, Abbot of Epinay; Hildegarde, Abbess of Rupertsberg; Milon, Archbishop of Beneventum; John of St. Amand, Canon of Tournay, did something for medicine as they understood it. Unfortunately, they generally understood its theory as a mixture of deductions from Scripture with dogmas from Galen, and its practice as a mixture of incantations with fetiches. Even Pope Honorius III did something for the establishment of medical schools; but he did so much more to place ecclesiastical and theological fetters upon teachers and taught, that the value of his gifts may well be doubted. All germs of a higher evolution of medicine were for ages well kept under by the theological spirit. As far back as the sixth century so great a man as Pope Gregory I showed himself hostile to every development of science. In the beginning of the twelfth century the Council of Rheims interdicted the study of law and physic to monks, and a multitude of other councils enforced this decree. About the middle of the same century

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* For the progress of sciences subsidiary to medicine even in the darkest ages, see Fort. pp. 374, 375. Also, Isensee, Geschichte der Medicin, pp. 225 *et seq.* Also, Monteil, p. 89, Heller, Geschichte der Physik, vol. i Buch II. Also Kopp, Geschichte der Chemie. For Frederick II and his Medicinal Gesetz, see Baas, p. 221, but especially Von Raumer, Geschichte der Hohenstaufen, Leipsic, 1872, vol. iii, p. 259.

St. Bernard still complained that monks had too much to do with medicine; and a few years later we have decretals like those of Pope Alexander III forbidding monks to study or practice it. In the beginning of the next century Innocent III, in the Council of the Lateran, forbade surgical operations to be practiced by priests, deacons, and sub-deacons; some years later Honorius III reiterated this decree and extended it. In 1243 the Dominican Order forbade medical treatises to be brought into their monasteries. Five years later the Council of Le Mans forbade surgery to monks, on the ground that "the Church abhors the shedding of blood," and many other councils did the same. At the end of that century Boniface VIII interdicted dissections as sacrilege.*

ICE-MAKING AND MACHINE REFRIGERATION.

By FREDERIK A. FERNALD.

THE manufacture of ice now bids fair to become a regular industry in temperate as well as in tropical climates. Pioneer work in this field was done more than sixty years ago, but it is only within the last ten years that the groping attempts of the early inventors have developed into processes sufficiently economical to make the artificial production of ice a commercial success. Artificial ice has been made in tropical countries and in our Southern cities for many years, but the industry has been greatly extended in this country by the two successive mild winters of 1888-'89 and 1889-'90. It has now gained a foothold even in our Northern States, while in the South comparatively small towns have their ice factories.

The scientific fact on which the making of artificial ice depends is that when a liquid evaporates it uses up a great deal of heat, which it draws from anything that happens to be around it. If a can of water is at hand, its temperature is reduced, and if the action goes far enough the water will be frozen. This cooling action can be felt by pouring a little ether or alcohol upon the hand. The liquid evaporates rapidly, and the loss of the heat which it takes up cools the hand very perceptibly. If a bottle

* For exact statements as to these decrees of the highest Church and monastic authorities against medicine and surgery, see Sprengel, Baas, Geschichte der Medicin, p. 204, and elsewhere; also, Buckle, Posthumous Works, vol. ii, p. 567. For a long list of Church dignitaries who practiced a semi-theological medicine in the middle ages, see Baas, pp. 204, 205. For Bertrarius, Hildegarde, and others mentioned, see also Sprengel and other historians of medicine. For clandestine study and practice of medicine by sundry ecclesiastics in spite of the prohibitions by the Church, see Von Raumer, Hohenstaufen, vol. vi, p. 438.

containing water is kept wet on the outside with ether, the evaporation will chill the water and eventually freeze it. This is essentially the process by which the *carafes frappées* of French restaurants are produced. The decanters filled with fresh water are set in shallow tanks containing brine, which remains liquid below the temperature at which fresh water freezes. In contact with these tanks are receivers, which can be kept charged with newly formed ether vapor. The chilling vapor cools the brine, and this in turn takes heat from the water in the decanters, which soon freezes.

In making ice on the large scale, either ammonia or sulphurous oxide is used instead of ether, because these substances are cheaper and are not inflammable. Ammonia is a gas or vapor at ordinary temperatures. What is commonly called ammonia, or, more properly, ammonia water, is water with several hundred times its volume of this gas dissolved in it. For ice-making, anhydrous ammonia—that is, ammonia perfectly free from water—is used. The first thing to do is to get the ammonia into the liquid form. There are two ways of condensing a vapor to a liquid—by cold and by pressure. Practically it can be done easiest by combining the two. The ammonia gas is subjected to pressure, and forced through a coil of pipe called a condenser, where it is cooled by water from any convenient supply running down over the pipes. By this means the latent heat in the gas is pressed out, and is taken up and carried away by the water. After being liquefied in the condenser the ammonia is forced into pipes larger than the liquid can fill, where it immediately expands into a vapor and exerts its chilling effect.

Two methods of making ice, which differ, however, in only one step of the process, are now in use. In a factory established last year in New York city, which the writer has been permitted to go through, the "compression system" is used, with anhydrous ammonia as the cooling agent. The machinery employed consists of a powerful pump driven by steam, with which is connected the necessary condensers, piping, etc. Liquid ammonia is supplied by the makers of ice machines in strong iron drums. The ammonia is run into a cylindrical iron tank, from which it is allowed to pass through a small orifice into the coils of pipe in the freezing tank. In this factory the freezing tanks are of iron, about twenty by fifty feet in size, and four feet deep. Over them is a floor, which is cut up into rows and lines of rectangular covers. Each of these lifts up, showing a can under it, twenty-two by eleven inches in size, and forty-four inches deep. The tank contains a brine of regulated strength, and the cans when filled with the water to be frozen float in this brine, coming within an inch or two of the bottom of the tank. Back and forth across the

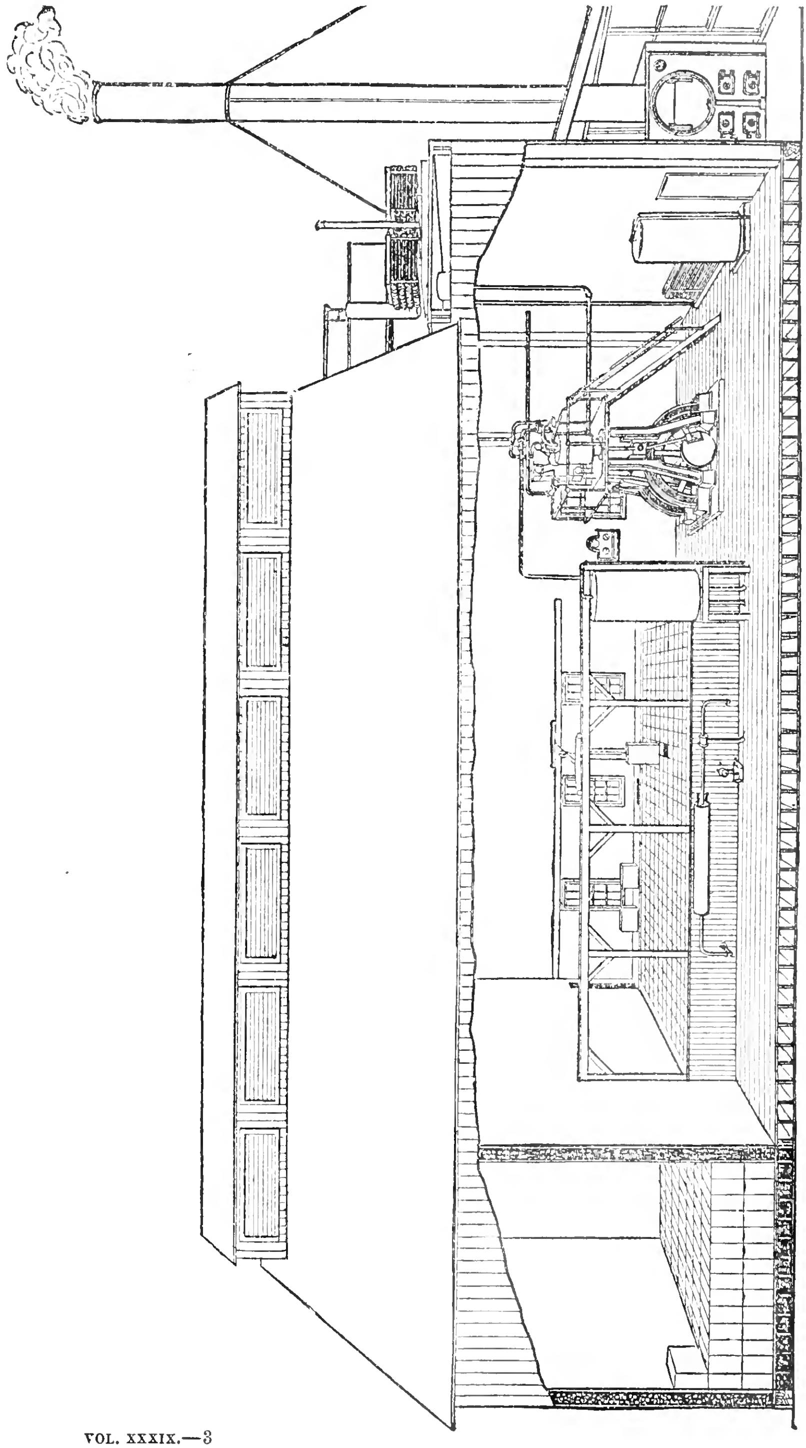

Fig. 1.—Interior of an Ice Factory.

tank, between the rows of cans, run the coils of pipe through which the ammonia passes. The evaporation of the ammonia constantly going on within this system of pipes cools the brine down to 15° or 18° Fahr. In order to equalize the temperature in all parts of the tank the brine is kept in constant circulation by a revolving agitator, which resembles a propeller-screw. Surrounded by this frigid liquid the water in the cans becomes congealed to uniform hard blocks of ice, weighing about three hundred and twenty pounds each. A tank of the dimensions above given contains five hundred cans. About sixty hours are required for the freezing process.

In Fig. 1 the tank, with its flooring, is shown in the middle of the building. To the right of this is the pump, and at the extreme right is the boiler-room. Over the tank is a traveling crane, by which the cans containing the ice are lifted out and conveyed to one end of the room. The crane consists of a beam, with a pair of wheels under each end, which travel on tracks six or seven feet above the floor. By means of the tackle hung from this beam a man raises a can of ice above the floor, and then pushes the crane with its load to the end of the room. Here the can is put into a sort of swinging box and tilted over into a slanting position, mouth downward. Tepid water is then allowed to run over the can from a line of small jets on each side. In two or three minutes the block of ice is melted free from the can and slides through a shute into the ice-house. The box is an automatic contrivance, and, as soon as the ice has left it, it reverses, turning the can upright and shutting off the water. In some factories the can is dipped into a tank of warm water to loosen the ice. In the figure, a can is seen suspended from the crane; at the back, under the middle window, is the small tank of warm water for dipping the cans; and in front of the next window two blocks of ice are lying. The room at the left is the ice-house. It has double walls packed with non-conducting material, and is shown with two layers of blocks in it.

The ammonia gas, after passing through the coils of pipe in the freezing tank, is drawn through a pipe into the great pump, where by the return stroke of the piston it is compressed and forced out through another pipe into the condenser. In Fig. 2 the condenser is shown in an upper room. It consists of several coils of pipe, over which cold water is kept running. The small pipes which run down obliquely from the ends of the coils are to carry away the ammonia as it becomes liquefied into the storage tank, which is the horizontal cylinder on the floor with the condenser. From the storage tank the ammonia, still under pressure, passes down into one of the large vertical cylinders shown in the lower part of the figure, and from this it goes into the expansion coils in the freezing tank, and passes again through the cycle of operations just described. The same ammonia is thus used over indefinitely. The pressure to which the ammonia is subjected in this apparatus ranges from one hundred and twenty-five to one hundred and seventy-five pounds per square inch. The pump, shown in the lower part of Fig. 2, is one of several makes. It has two compression cylinders, seen at the top of the tall A-shaped frame. The piston-rods work vertically beneath these cylinders, and are connected by cranks and connecting-rods to the piston working in the steam-cylinder seen at the right. The use of the ammonia in making ice can be compared to the use of a sponge in baling a boat. As the sponge soaks up water from the bottom of the boat, and after being squeezed over the side is ready to soak up more, so the ammonia soaks up, as it were, heat from the water to be frozen; and, after this has been squeezed out by the compressor, the liquid is ready to take up more heat.

The water from which the ice is made in the New York factory, previously mentioned, is from the city supply (Croton). Before being frozen it is purified by filtering and distillation. It is first filtered, then converted into steam in vertical boilers about twenty feet high; the steam is condensed and again filtered in steam filters filled with coke. The condensation is effected by placing the filters in the open air on the roof of one of the buildings, and circulating around them water pumped from the river, near which the factory is located. After leaving the steam filters and condensers, the water is further cooled by passing through a cooler similar to the condenser used for the ammonia. After leaving the cooler, the water is filtered through charcoal, and is then ready to go into the cans. It is filled into them through a hose, which ends in a long nozzle, containing a patented device that prevents air from being carried down into the water. In order to make clear ice, the formation of air-bubbles in it must be prevented. Water always contains some air, which is driven out by boiling. When boiled water is frozen, the ice contains only what little air is absorbed by the water while it is being cooled down to the freezing-point. The artificial ice, therefore, is clear except a thin layer running lengthwise through the middle of the cake—the part that freezes last. A very attractive exhibit for a market is made by putting meat, fish, fruit, and flowers into cans of water and freezing them into the clear ice. Articles having smooth surfaces, and consequently few crevices in which air-bubbles can cling, give the best results.

It was mentioned early in this article that sulphurous oxide is used as a cooling agent in making ice. This is the choking gas that is formed when sulphur burns. An ice machine employing anhydrous sulphurous oxide is made, which, as it works accord-

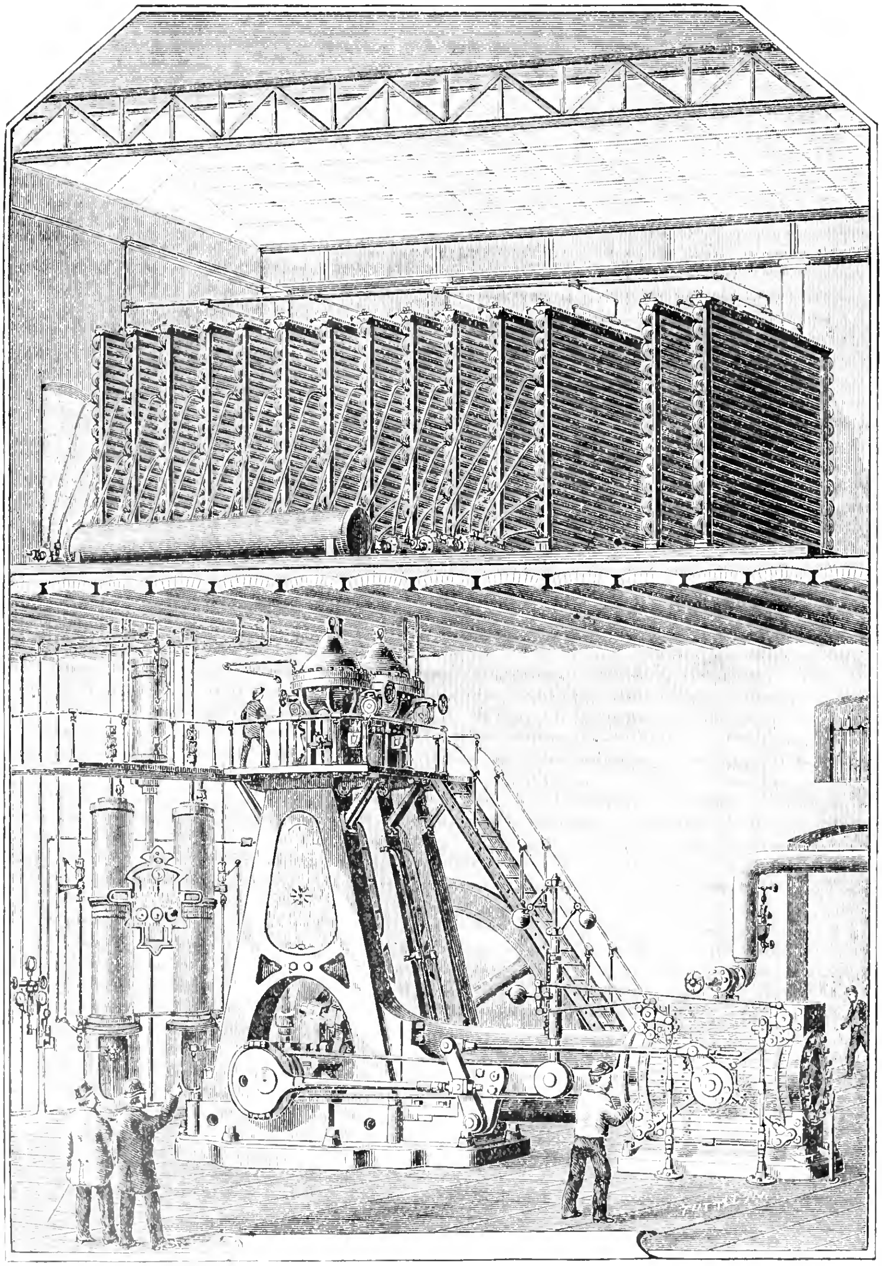

FIG. 2.—AN AMMONIA-COMPRESSION ICE MACHINE.

ing to the "compression system," like the ammonia machine just described, necessarily has the same essential parts, though differing somewhat in form and arrangement. It uses a brine made from magnesium chloride instead of common salt.

There is also a class of ammonia machines, that operate on what is called the "absorption system." In these machines the operation starts with ammonia water instead of anhydrous ammonia. The liquid is heated in a boiler, and a mixture of about nine parts ammonia gas and one part steam is driven off from it. The mixed vapors pass first into a rectifier, where most of the steam is condensed to water, which runs back into the boiler. The temperature in the rectifier is not low enough to condense the ammonia, which passes on, now nearly free from water, into the condenser. Here it is liquefied by the joint action of cold and pressure, only the pressure is not supplied by mechanical means, but by the expansive force of the stream of vapor that is constantly being driven out of the boiler. The liquid ammonia next passes into the expansion coils in the freezing tank, just as in the compression system. After doing its work the gas is led into an "absorber," which is very similar to the condensers already described. Here it is reabsorbed by the water that it was originally driven out of, this water ("poor liquor" it is called) having been forced out of the boiler by the pressure prevailing in it and cooled for the purpose. It is this operation that gives the name to the absorption system. The resulting solution of ammonia is returned to the boiler by a pump and begins again the same round of operations.

In hot climates natural ice is an expensive luxury, as it must be brought long distances, and suffers much loss from melting. In those regions the artificial product has a great advantage in respect to cost. Even where there is usually a cold winter, as in the northern United States, a failure of the ice-crop sometimes occurs in the fields usually depended upon, followed by a more or less necessary increase in price the following summer. Ice machines have now reached such a high degree of efficiency that their product can compete with natural ice in these latitudes. In the summer of 1890 the price of natural ice to families in New York was a dollar a hundred-weight, while artificial ice sold for fifty cents. No doubt further improvements in machinery and methods will be invented, which will make it possible to furnish ice at a still lower price than now, and will lead to a freer and more general use of this commodity. Not only can artificial ice be sold at a lower price than the natural in most markets, but it is more economical, for the reason that it does not melt so fast. This is because it is frozen without the interruptions that allow layers of bubbles to collect under natural ice formed on still water, and it contains no soft snow-ice. It is, therefore, more compact than any but the very best of the natural product.

Another advantage that is claimed for artificial ice is, that when made from distilled water it is free from the impurities that natural ice sometimes contains. Nearly all natural water contains considerable numbers of bacteria, many of which are derived from the sewage discharged into some lakes and rivers from which ice is cut. It is commonly believed that water in

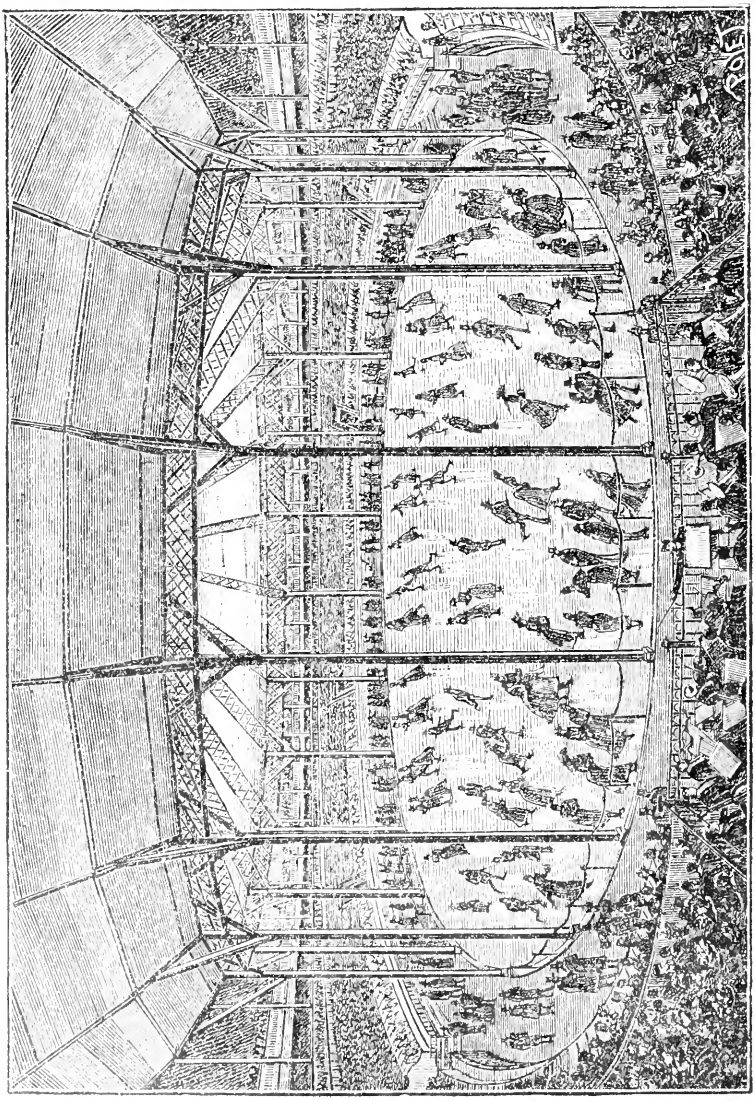

Fig. 3.—Rink of Artificial Ice in Paris.

freezing purifies itself from all kinds of contamination, but Dr. T. M. Prudden has shown in this magazine that the truth is otherwise. In his article on Our Ice-supply and its Dangers (Popular Science Monthly for March, 1888) he says:

A great deal of careful experiment has shown that water in freezing largely expels its coarser visible contaminations, and also that a large proportion of the invisible bacteria which it contains may be destroyed, even as many as ninety per cent. But still large numbers may remain alive, for many species are quite invulnerable to the action of cold. It has been found that in ice formed from water containing many bacteria, such as water with sewage contamination, the snow-ice almost invariably contains many more living bacteria than the more solid, transparent part; so that the snow layer should be especially avoided in ice obtained from questionable sources. Unfortunately, the bacteria which cause typhoid fever are not readily killed by cold, and may remain alive for months, fast frozen in a block of ice.

As the neighborhood of our ice-fields becomes more thickly settled, and the demand for ice also increases, the danger that frozen filth will be served out to consumers of ice will increase likewise. It is fortunate that the artificial process stands ready to shield us from this peril.

Utility has not entirely monopolized the artificial production of ice; it has been made to serve sport as well. About 1875 a Mr. Gamgee, in England, constructed a rink of artificial ice for summer skating, and several others have been made in that country. In 1889 an immense rink of this kind was established in Paris, circular in form and one hundred and seventy feet in diameter. Around the sheet of ice was a promenade over seven yards wide,

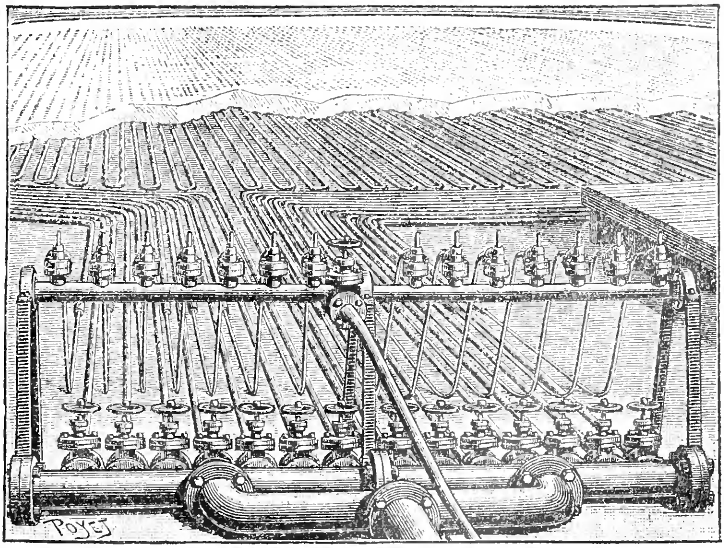

FIG. 4.—ARRANGEMENT OF THE EXPANSION COILS IN A RINK IN PARIS.

and outside of this were placed seats for spectators, a band-stand, etc., the whole being covered by an arched roof. The arrangement of this rink is shown in Fig. 3. The ice-sheet was formed on a concrete bed, upon which lay an immense coil of iron pipe, as shown in Fig. 4, having a total length of ten miles. The pipe was of an inch and a quarter internal diameter, and the lengths were placed five inches apart. Through this coil the ammonia circulated, the absorption system being used to effect the congelation.

The machines with which ice is made have also another and up to the present time a larger application. This is the production of cold in breweries, abattoirs, markets, and cold storage

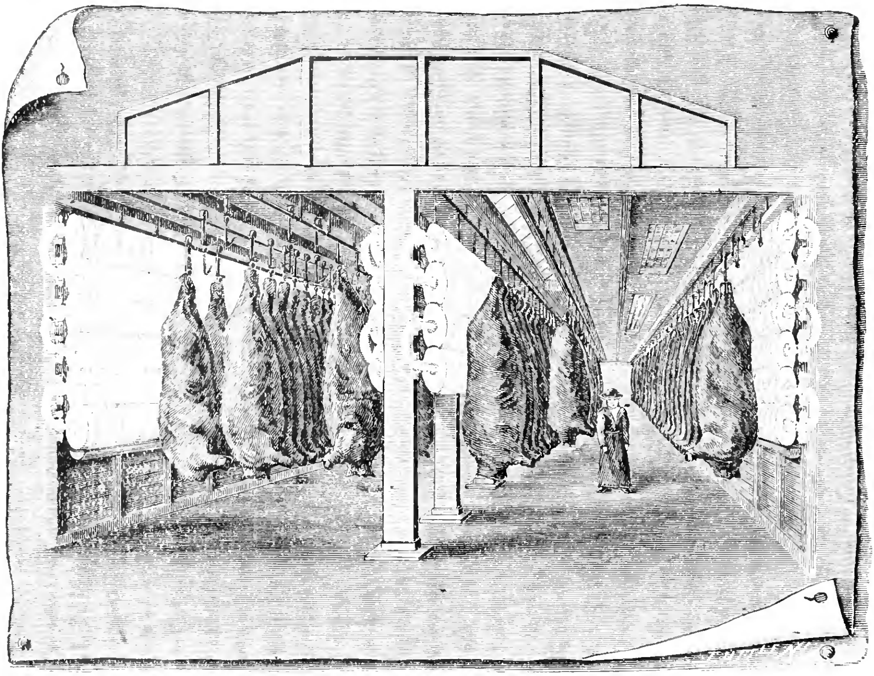

Fig 5.—A Room in a Cold Storage Warehouse.

houses. The fermentation of beer must take place at quite a low temperature, which must be steadily maintained; hence energetic and continuous cooling of the wort has to be provided for. The brewers were formerly among the largest customers of the ice companies, but now nearly every brewery has a refrigerating machine of its own, and more machines are used by them than by all other users put together. No ice is made with these machines, except for packing beer for shipment, as the cooling required can be accomplished more conveniently by circulating cold brine or cold fresh water in pipes where it is needed.

The system of cold storage which has sprung up within the past few years has been made possible by this same process. Immense quantities of meat and other perishable provisions are now kept in great warehouses until wanted, thus insuring a steady supply to the consumers in our large cities. The provisions, when brought into these buildings, have the temperature prevailing outside, and warm the air that comes in contact with them. This air rises into a loft, where it comes in contact with pipes containing cold brine, becomes chilled, and descends through flues to the room below, entering it near the floor. This circulation goes on until the provisions have been cooled down to the temperature of the room. The air may be cooled, also, without the use of brine, by letting it come in contact with the coils in which the ammonia expands. Air has also been used direct for the production of cold by compressing it. Like condensed ammonia, it takes up much heat in expanding to its ordinary volume, but this system is not economical. In Fig. 5 a somewhat different arrangement is represented. Where there is not space for the loft, the expansion coils may be placed in the same room with the provisions. Before refrigerating machines came into use, refrigeration on the large scale had been tried with ice, and had failed. This was owing to the dampness imparted to the air by the melting ice. The brine or ammonia coils not only do not add any moisture to the air, but even withdraw a great deal that it naturally contains. This moisture becomes condensed on the pipes as the air circulates around them, and makes itself visible as a gleaming white coating of hoar-frost. On board steamers, machines are employed both to preserve dressed meat and to prevent live cattle transported through tropical regions from dying of the heat in their confined quarters. Machines of moderate size also find application in hotels—two of the recently built houses in New York have them—in dairies, chocolate factories, and they are used also in making stearin and margarin, in rectifying alcohol, extracting paraffin from petroleum, etc. A machine of the size represented in Fig. 2 will produce a refrigerating effect equal to that obtained by the consumption of two hundred and twenty tons of ice a day, or it will make one hundred and thirty tons of solid ice daily. The company that makes this style of machine is now building one of three hundred tons refrigerating capacity, which will be the largest in the world. But that is soon to be exceeded, as the contract is already made for a five-hundred-ton refrigerating machine.

Artificial refrigeration has also been applied to sinking shafts and driving tunnels through quicksand and loose wet gravel. These materials wash into an excavation as fast as they are removed, and in many cases progress through them is next to impossible by ordinary methods. The difficulty is overcome by freezing the loose soil around or in front of the work. This process was first used by a German mining engineer in 1883. In sinking a shaft, pipes of about eight inches diameter are driven down in a ring around the place of the proposed excavation. A brine, cooled to within a few degrees of 0° (Fahr.), is sent down through an inner pipe and returns through the space between the two pipes. By this means a cylinder of the wet earth is frozen, within which the digging is done and the lining of the shaft put in place. The core of the cylinder which is to be removed will be partly or wholly frozen, according to the degree of refrigeration employed. Frozen quicksand looks like a fine-grained sandstone, and is about as hard to cut through.

Those who are acquainted with the history of invention, will not be surprised to learn that the Asiatics were centuries ahead of us in the making of ice, as in the use of gunpowder, the compass, etc. Ice has long been made in India by the following method: Pits two feet deep and twenty or thirty feet square are dug in a large, open field, and about half filled with straw. After sunset shallow dishes of porous clay are placed on the straw and water is poured into them. The rapid evaporation of part of the water, assisted by the radiation of heat from the straw, chills the water remaining, and, if the night is favorable, thin sheets of ice form in the pans by morning. The operation is most successful when the sky is clear and a gentle dry breeze is blowing. Although we of the Western world have clearly been anticipated in producing ice artificially, we may still claim the superior credit that our process has not remained stagnant for generations, but has achieved many of the possibilities that have been open to it, and become independent of such limitations as the state of the weather, and others that hamper the operations of the "gentle Hindoo." *

FORTIFYING AGAINST DISEASE.†

By SHERIDAN DELÉPINE, M. B.

THE intense excitement and the unbounded hopes created by the announcement that a cure for consumption has at last been found have led me to lecture to-day on a subject which I generally relegate to the end of my course of pathology. For, after discussing the various phenomena which are brought about by disease, and attempting to connect these phenomena with their cause, apparent or real, it is natural to try to explain why these

* For the electrotypes of Figs. 2 and 5 in this article I am indebted to the courtesy of the De La Vergne Refrigerating Machine Company.

† On Development of Modern Ideas on Preventive, Protective, and Curative Treatment of Bacterial Diseases, and on Immunity or Refractoriness to Disease. A lecture delivered at St. George's Hospital on November 20, 1890, on the occasion of the publication of Koch's method for the cure of tuberculosis.

causes do not always bring about the results which are observed only in a certain percentage of cases.

EFFECTS OF INDIVIDUALITY, AGE, SEX, FAMILY, RACE, SPECIES.—It is a matter of common experience that in times of epidemics persons equally exposed to infection are not all affected. The weak members of the community are generally more readily affected than the strong ones, the starved than the well fed, the intemperate than the temperate, the fearful than the fearless; but, apart from these often doubtful distinctions, some other influences must be at work in helping some to resist, for many a man or woman of weak constitution has been able to pass through plagues that had carried away more than one of powerful frame. This resistance of some individuals to disease has probably at all times attracted the attention of men, and very early in the history of civilization observations have been made which by gradual extension have led to some of the most striking triumphs of medicine. It will be my object in this lecture to show you how immunity to disease, at first supposed to be due to individual peculiarities or supernatural influences, has gradually become connected with certain external circumstances acting directly or indirectly. Among the factors which are generally discussed in medical books as influencing the liability or immunity of certain individuals to disease I may mention age, sex, family, and race. These, as far as we can see at the present time, have an influence on the occurrence of disease which is in many instances difficult to explain. Some facts, however, tend now and again to lighten our ignorance, and to show that even these apparently inherent qualities are perhaps the result of the transmission of acquired properties through generations of cells or of individuals. This will be more evident perhaps if, by extending our field of observation from one to several kinds, we consider how the immunity of certain species, orders, or even classes of animals is brought about. Take, for instance, the remarkable immunity of the fowl and of the frog to anthrax. At first sight it seems impossible to understand why a small animal like a frog or a fowl should be able to resist a disease that is so rapidly fatal to such large animals as the sheep, man, or even the ox. Pasteur, however, more than twelve years ago recognized that the difference of the body temperature of the various animals was enough to affect the development of the parasite. He immersed a fowl for two days in water, bringing the temperature down to 28° C., and showed that the fowl was as liable to anthrax as any other animal. A similar observation was made later on by another observer, who by raising the temperature of a frog rendered it also liable to the disease. Thus it was demonstrated that certain conditions of temperature were necessary for the anthrax bacillus to attain its full virulence. What temperature does in these cases chemical products, special to certain animals, can also bring about in others. This is well proved by the influence of various culture media on the growth of micro-organisms. The presence of chemical compounds of well-known nature, even in very small quantities, has been shown by a great many observers to influence much the mode of growth of bacteria. It has even been proved that bouillon obtained from the muscular tissue of various animals, notwithstanding the absence of any very definite active chemical compound causing marked difference, gave cultivation media more or less suitable for the growth of certain organisms. I will only mention out of a large number of other observations the very recent experiments of Hippolyte Martin on the *Bacillus tuberculosis*. This observer found that animals can be classified roughly in the following way, according to the ease with which the bacillus grows in bouillon made with their tissues: herring, oyster, mussel, monkey, horse, calf, rabbit, birds, dog, cat, rat. It would be difficult in the present state of our knowledge to ascribe these differences to the presence of any definite compound, yet it can not be doubted that they are due to certain physico-chemical properties. We have thus distinct evidence of marked differences between animals of different classes, orders, and species; and, if we admit the truth of the doctrine of evolution, we must admit that such differences are in great part the result of the influence of external circumstances. We might infer from this that differences between animals of the same species, but of different races, families, sex, or age, are likewise the result of similar influences; we have, however, better evidences than these in support of the view that either extreme liability or immunity to disease may be acquired. Indeed, I shall be able to show you that it is the gradual development of that knowledge which has prepared man for the reception of Pasteur's discoveries, and of their recent momentous extension by Koch.

Refractory State resulting from a First Attack of Certain Fevers.—It was very early recognized that after a first attack of many infectious fevers, such as small-pox, measles, typhus fever, etc., a second attack seldom occurred. This fact seems to have been observed more specially in connection with small-pox, or at any rate to have led to practical application first in connection with that disease. We learn that the *inducement of a first attack of small-pox* was an antique practice in Africa, Persia, and China, and that the method of inoculation was brought from there to Constantinople in 1673, and from that town to England by Lady Mary Wortley Montagu. The idea was evidently to produce a mild attack of the disease in individuals placed under circumstances most favorable to recovery in order to induce immunity. The practice, although open to serious objections, must have had no little success, and was much resorted to in the middle of the last century. Another practice which is not so rare as one might be inclined to believe is the *inducement of measles.* Many people are under the impression that unless children have had all the ordinary exanthematous fevers it is almost desirable that an opportunity should occur for them to have mild attacks of these fevers; and I have known of instances in which, one out of several children being attacked with measles, no attempt has been made to isolate the sick child, for, it was argued, it was as well for the other children to have the fever also and be done with it as soon as possible. Since this has been done under the influence of a popular belief, I think I am justified in suspecting that the practice of inducing measles for protective purposes is far from uncommon, although not generally carried out by professional men. Boeck and Sperino introduced about 1854 the practice of *syphilization,* and these authors recognize clearly that this method is not only a prophylactic, but also a truly therapeutical one. The inducement of a certain disease in order to prevent its recurrence, and even to modify the course of an attack, was therefore a method early recognized in this century both in connection with smallpox and syphilis.

Refractory State produced by Inoculation of an Allied Disease less Fatal, or of the Disease modified by Passage through another Animal.—Certain country people had early suspected that a disease affecting cows was communicable to man, and that individuals thus affected were not so liable as other people to smallpox. History tells us that an English farmer and a German schoolmaster in the course of the last century, under the influence of that belief, had resorted to inoculation of that cow disease in preference to the inoculation of true variola. Jenner was the first medical man who discovered the immense importance of these traditional beliefs and practices, and after devoting all his energy to the study of the subject became so convinced of the value of the method of vaccination that after a long struggle he has succeeded in convincing others, and has become thus one of the greatest benefactors of the human race. From 1798—when Jenner brought vaccination before the world—up to 1880 very little was done to extend the scope of the principle thus discovered. Then Pasteur arose, who, after studying for many years the nature of the virus causing several diseases, became gradually convinced that this virus may become intensified or attenuated at will, and in 1880 was able to state positively that the production of an attack of definite intensity of many infectious diseases was a thing not only possible, but also practicable and capable of application for the prevention of disease. In 1880, also, Burdon Sanderson suggested that the attenuation of the virus of anthrax for the purpose of vaccination might be obtained by using the guinea-pig as an intermediate host. Greenfield experimented also at the same time and in the same direction with very satisfactory results. In 1883 Pasteur and Thuillier made experiments in the *rouget des porcs*, showing clearly that by causing the virus to pass through a series of pigeons it became gradually more virulent for the pig; while the reverse was true when series of rabbits were used as intermediates, showing thus at the same time how disease may originate or be modified. The principle of vaccination as introduced by Jenner seemed therefore to have become a fact capable of general application by this time. All that seemed necessary was to find a suitable intermediate host for the parasite. By growing the parasite in a series of such intermediate animals one was able to obtain a "vaccine" or "lymph," which, like that of vaccinia, was capable of inducing immunity, as well as an attack of the unmitigated disease would have, but without the same danger. Another fact of great importance has also been noticed by several observers—viz., that the occurrence of certain febrile affections may modify the course of other febrile affections previously established. Daniellsen and Boeck were perhaps the first to notice this fact, and to record the beneficial influence which an attack of small-pox might have on the course of tubercular leprosy. I need not refer to the numerous attempts which have been made since in that line.

Refractory State produced by Inoculation of a Virus modified by Cultivation outside the Body.—Another discovery, more fertile in results, although similar in principle, was, however, made known by Pasteur in 1880. He showed that by cultivating the microbe causing chicken cholera at a temperature of 33°, with free access of oxygen, he could obtain in from two to eight months an attenuated virus, which would cause the disease in a form mild, but sufficient to produce immunity. Toussaint and Chauveau were experimenting at the same time on the anthrax bacillus. Toussaint made the important discovery that, by heating cultivations of the *Bacillus anthracis* rapidly to a comparatively high temperature, its virulence was attenuated. In 1881 Pasteur produced attenuation of virulence of the *Bacillus anthracis* by cultivation for nine days at a temperature of from 42° to 43° C., and produced immunity by vaccination with the modified virus. Koch, Gaffky, and Loeffler repeated Pasteur's experiment in 1884, confirmed his results, and extended them, differing from him only with regard to the influence which he attributed to oxygen. In 1882 Pasteur and Thuillier applied to the bacillus of "rouget" the same principle as that used in the case of the chicken cholera and splenic fever, and succeeded in attenuating that virus also. During the whole of this period Pasteur was occupied in trying to isolate the virus of rabies. Although he did not succeed in doing so, he discovered that the nervous tissues acquired in that disease virulent properties which indicated the presence in them of some unknown virus. Not being able to obtain the virus itself, Pasteur used the nervous tissue as he would have a nutrient medium, and having discovered the method of obtaining spinal cords having a constant virulence (fixed virus), he dealt with these cords in the same way as he would have with ordinary cultivations, and thus succeeded (1885) in attenuating the virus and being able to produce immunity by vaccination, as in the case of the other diseases. Many other methods have been proposed for attenuating the virulence of organisms than those introduced by Pasteur. We have already seen how Toussaint and Chauveau used rapid heating. Paul Bert showed that oxygen under high pressure (twenty atmospheres) kills the *Bacillus anthracis*. Toussaint, Chamberland, and Roux (1880–'86) added dilute carbolic, chromic, and sulphuric acids to nutrient media for the same purpose. Klein (1888) used also very small quantities of corrosive sublimate for the same purpose. Arloing (1886) showed that bright sunlight has also an attenuating effect on cultivations in fluid media. It is useless to go into the further developments of these methods, that of Pasteur being the only one which has had very extensive application as yet so far as man is concerned.

Refractory State produced by the Introduction into the System of Definite Chemical Products resulting from the Action of Pathogenic Organisms on Cultivation Media.—Salmon and Smith (1883) seem to have been the first to realize the practical importance of the injection of the products of growth of organisms independently of the organisms themselves. They showed that the injection of cultivations of the microbe causing hog cholera produces the effects of attenuated virus after being sterilized by heat, at any rate in the case of pigeons. (It was, however, accepted before that time that micro-organisms generate products which are deadly to themselves and are capable of arresting their growth, a fact which has also long been known in connection with fermentation organisms.) Pasteur very early showed also that filtered chicken-cholera bouillon injected into a bird produced the symptoms of the disease, although no organism was present in the fluid. He showed also that the same is true of the blood of animals affected with anthrax.

In attempting to explain the effects of inoculation with spinal cord for rabies, Pasteur also alluded, in 1885, to the probable existence of some chemical compound in the cords which he used for protective inoculation, and suspected that this compound was instrumental in bringing about immunity. It was only about 1887 that these facts and views acquired fresh significance by the work of Toussaint, Chauveau, Wooldridge, Chamberland, and Roux on anthrax; of Charrin on the pyocyanic bacillus disease, of Chamberland and Roux on acute septicæmia, etc.; of Brieger, Chantemesse, and Vidal on typhoid fever; of Roux on symptomatic anthrax, and of Roux and Yersin on diphtheria. In most of these experiments the material used for inoculation was the cultivation medium modified by the growth of the organism, and sterilized either by heat, by filtration, or by both methods. The work of Charrin, Woodhead, Cartwright, and Wood has also shown that protection may sometimes be obtained not only by injection of the products of the growth of the pathogenic organism itself, but also of some quite different ones (*Bacillus anthracis* and bacillus of blue pus).

The products used were therefore of a very complex nature, and it was not known to what kind of compound they owed their property of conferring immunity. Roux and Yersin had, in 1888, tried to prove that their chemical vaccine for diphtheria owed its properties to an albuminoid body allied to unorganized ferment, but this last supposition is not generally accepted, although not disproved. (In order to understand the origin of the following improvements it is important to remember that the work of Panum (1856), Gautier and Selmi (1873) had revealed the production of very poisonous alkaloidal substances during putrefaction. The more accurate researches of Nencki, and still more of Brieger, demonstrated clearly the existence of an important class of poisonous alkaloids produced by the micro-organisms of putrefaction. Gautier (1881), on the other hand, was trying to prove that animal tissues are also capable of producing by their metabolism poisonous substances of allied nature. The experiments of Lauder Brunton and Sir Joseph Fayrer on cobra poison (1873) should be kept in mind in relation with this subject. It was soon found that, besides these poisonous albuminoids, other more or less poisonous products might be manufactured either by animal or vegetable cells; these products were found to belong to the ill-defined class of albumoses. I need only refer to the work of Weir Mitchell (1860) and Reichert on the albumoses of snake poison; of Sydney Martin on phytalbumoses—i. e., albumoses produced by vegetable cells, whether bacterial or others—an important work, which led him to infer later on that albumoses were products intermediate between the non-poisonous albuminous substances of the culture media and the most poisonous alkaloids. Büchner, Wooldridge, Hankin, and others were also discovering toxic albuminous substances in various fluids or tissues of the body, some of which were deadly to bacteria.) Returning now to preventive inoculation, we find that in 1889 Sydney Martin in London, and Hankin of Cambridge, working in Koch's and Brieger's laboratories, had isolated from cultivations of the *Bacillus anthracis* albumoses which were found by Hankin to produce immunity from the disease when injected into the body. Possibly under the influence of Hankin, *certainly later in the year*, the important researches of Fraenkel and Brieger on the toxalbumins of diphtheria, typhoid fever, cholera, tetanus, etc., were published. Thus, just as in the case of many remedies used for centuries in the shape of powders, extracts, decoctions, infusions, tinctures, etc., active principles have ultimately been discovered by chemists, *it was now found that out of the material used for the last ten years by Pasteur and his school, it was possible to isolate some active products of definite composition*, to which the lymphs or "vaccins" owe their prophylactic and curative properties. Such was the state of science when, in the course of last year, it was announced that Koch had found the means of curing phthisis by inoculation. All minds were to a certain extent prepared for such an announcement; yet the fact that one of the greatest scourges affecting human kind had at last come within the pale of treatment has created immense sensation. The little that is known of the treatment and of its effects seems to point clearly to the fact that Koch is using some of the chemical products which have just been discussed, and therefore there is good reason to expect that *a certain amount of success* will attend the method. The results of previous experimenters show, however, that it would be wrong to hope too much from a system which has always been attended with *a certain proportion of failures.*

I have carefully avoided in this *exposé* to enter into many details, some of which are of great importance, in order that you should be able to follow the main line of observations and thoughts which have led to the recent discovery. I will therefore not attempt to discuss on what basis vaccination, essentially prophylactic in principle, may become a curative method when the modified virus answers certain requirements. There is a very distinct connection between these two methods of treatment.* It may, however, be interesting to consider for a moment the methods which the knowledge of pathogenic organisms has introduced in medicine.

These methods can be subdivided into three classes: (1) The preventive, (2) the protective, (3) the curative. They have all something in common, and yet they all differ, as will be seen in the following brief enumeration:

1. The *preventive method* consists in *destroying or attenuating*

* For explanation as to the mode of action of the products used in vaccination, see Lauder Brunton's lectures on Chemical Structure and Physiological Action, especially Lecture II (British Medical Journal, vol. i, 1889, p. 1389).

the cause, or avoiding it in some way or other so that the body may remain unaffected. (*a*) The *antiseptic method* introduced by Lister is a good instance of the methods which aim at *destroying the cause* before it has acted. (*b*) *Residence* in high localities, *drainage*, etc., are instances of the methods by which the causes of disease may be so *attenuated or diluted* as to become harmless. (*c*) *Absolute cleanliness. Aseptic* methods are based on the possibility of avoiding certain causes entirely without destroying them.

2. *Protection* consists in so *modifying the possible host* as to render it able to resist virulent parasites. This can be done either by (*a*) increasing its *strength* and activity, as by diet, warmth, functional activity, and other hygienic conditions (Wargunin); (*b*) rendering its tissues and fluids *unsuitable media* for the *growth* or *full development* of the parasite—*inoculation* and *Jenner's vaccination* are good instances of that method, which has been further extended by Pasteur and others; (*c*) by establishing *tolerance* (Sewall, 1887).

3. The *curative methods* consist in *attenuating* or entirely destroying the virus causing the disease *after it has penetrated into the body*. (*a*) The *actual destruction of the parasite within its host* is apparently still a desideratum. (*b*) *Attenuation of the virulence* can be obtained by introducing into the blood and tissues some product either interfering with the full development of the parasite or modifying the tissues and fluids of the body so as to increase their resistance to the extension of the parasite or to its products. This seems to be the chief principle at the root of Pasteur's *vaccination* for hydrophobia, etc. (*c*) *Neutralizing the physiological action of the virus by using its physiological antagonist.* Muscarine, for instance, may be antagonized by atrophine. Lauder Brunton (1873) directed attention to the possibility of applying this principle to the treatment of cholera. (The same idea has been applied to the treatment of poisoning by snake venom. Wynter Blyth, 1877; Lacerda, 1881.) (*d*) *Destroying and removing the substratum* or ground which has become contaminated by the parasite. This is *apparently the view which Koch has taken of the action of his lymph.* The action of the product on the tissues is, however, of the *same kind as that of the substances used in some of the methods already mentioned*, but more intense, and Koch's views will probably have to be modified.

In this attempt to analyze the methods which have been proposed I have separated processes, many of which may act concurrently. This is, however, of little consequence, for my object was less to give an account of any single method than to trace the development of the ideas which are at the basis of the treatment of bacterial diseases. In this way I hope I may have been able to show you how *science* prepares the way for the highest branches of the *art*—viz., *preventive, protective, and curative medicine.—London Lancet.*

SOME GAMES OF THE ZUÑI.

By JOHN G. OWENS.

PLAY finds its best exemplification in the Indian of the Southwest. Living in a mild and genial climate, naturally shiftless and improvident, this true child of Nature consumes his exuberant vitality by play instead of work. Step to the bank of the Zuñi River on one of those supreme mornings in August, which only the matchless climate of New Mexico knows, and you will behold a sight which for genuine mirth and romp will surpass that of any Eastern outdoor gymnasium or children's park. The river, a stream of less than ten feet, winds like a serpent through a sandy bed about one hundred feet wide. This river-bed is the chief playground of the Zuñi child. Here boys and girls, some clad, some with only ear-rings or a chance necklace, are bathing, racing, wrestling, throwing sand, perchance riding some razor-backed hog; everywhere are life and merriment. I think it worthy of note that not once during the whole summer did I see a quarrel of any kind.

This spirit of playfulness remains with the boys and characterizes their later life. Not so with the girls. These, to the age of thirteen or fourteen, are very jolly and playful, but after that they begin to age very rapidly. This is probably the result of early marriage, a custom of the tribe. Zuñi seems to have no class of buxom young women; the transition is from joyous, frolicsome girlhood, to sedate and sober womanhood.

But, beside these sports of childhood, there are a few games which deserve our attention. They are not limited to any age, but, so far as I know, are confined to the male sex.

Before describing these games I wish to acknowledge the kind assistance of Mr. D. D. Graham, the trader—a gentleman of culture, who has lived among the Zuñis many years, and is perfectly familiar with their language. Although some of these games are seldom played in summer, yet through his co-operation I have witnessed nearly all of them.

Pō-kē-an.—This game is somewhat similar to our popular game called battledoor and shuttlecock. Green corn-husks are wrapped into a flat mass about two inches square, and on one side are placed two feathers, upright; then, using this as a shuttlecock and the hand for a battledoor, they try how many times they can knock it into the air. Some become very skillful in this, and as they return the shuttlecock to the air they count aloud in their own language—*Tō-pa, quil-ē, hī, ă-wē-ta, ap-ti,* etc. The striking resemblance to our European game suggests a common origin, and it may easily have been introduced through contact with the Spaniards. This, however, is doubtful, and I am inclined to think that we must give the Indian the credit of inventing this game rather than borrowing it, as similarity of product by no means proves identity of origin.

Shō-wē-es-tō-pa.—The number of players is unlimited. Each one has several arrows. One throws an arrow on the ground eight or ten feet in front of him, the others follow in turn, and, should the arrow thrown by any one cross that of another at the beginning of the feathers, he takes it. The limits of success are very small, and skillful throwing is required to win the arrows of another. This game is but little played at present, and I am doubtful whether the younger men of the tribe know how to play it. José California (so named because he made a trip to California on a burro) played it for me. The decline of the game is probably due to the decline of the use of the bow and arrow, but I think it has left a descendant in

Lō-pō-chē-wā.—This is played only by the boys. Instead of arrows they use pieces of bone two or three inches long with feathers tied to them. You may see five or six boys playing this game in all parts of the pueblo at any time during the summer. They generally touch the bone to the tongue before throwing it, to make it stick. The principle of the game is the same as that of the one just described.

Than-kā-lā-wā.—This game is usually played in the spring, and resembles somewhat our game of quoits. In place of the ordinary quoit they use flat stones. Any number may take part. A small stone or even a corn-cob is set up, and on this each places his stake. To determine who shall pitch first, they all throw for some distant point. He who comes nearest to the mark chosen pitches first, and each one follows according to his throw; then the game begins. The distance pitched is nearly one hundred feet. The object is to knock over the stake or pool. If the pool is knocked over, and the stone pitched goes beyond it, it counts nothing; if just even with it, the one who pitched has another chance; if it remains behind, he takes everything, and all put up again. They count it great sport, and some become very skillful in pitching.

*A-we-wō-po-pa-ne.**—This is played by only two persons, but each usually has several backers, and considerable betting is

* There is a slight resemblance in this contest to our sport, the potato race.

done. One place is designated as the stone-home. One hundred stones are placed in a row a certain distance apart. Each stone must be picked up and carried separately and placed, not thrown, in the stone-home. Another point, several miles distant, is taken, and the game is for one to run to the distant spot and return, while the other gathers up the stones. As it is a contest of speed and judgment, not chance, it becomes very exciting.

This almost inordinate desire for play, which I have claimed for the Zuñis, seems not to be of recent origin. The three games, *shō-wē-es-tō-pa*, *shō-lē-wā*, and *ti-kwa-we*, were "played by the Zuñis as soon as they came out of the ground," as one expressed it. That this expression may be better understood, I will quote from Mrs. Stevenson's article on The Religious Life of a Zuñi Child:* "Let us follow the Zuñi tradition of the ancient time, when these people first came to this world. In journeying hither they passed through four worlds, all in the interior of this, the passage-way from darkness into light being through a large reed. From the under world they were led by the two little war-gods, Ah-ai-ū-ta and Mā-ā-sē-we, twin brothers, sons of the sun, who were sent by the sun to bring these people to his presence. They reached this world in early morning, and seeing the morning star they rejoiced, and said to the war-gods, 'We see your father, of whom you have told us.' 'No,' said the gods, 'this is the warrior who comes before our father'; and when the sun rose the people fell upon the earth and bowed their heads in fear."

Shō-lē-wā.—This game was played for me by Boots and José California. They have four pieces of reed about four inches long. These are differently marked; on the concave side, painted in places, and on the convex side marked with carvings, as shown in Fig. 1. Each piece is named. The one whose concave side is en-

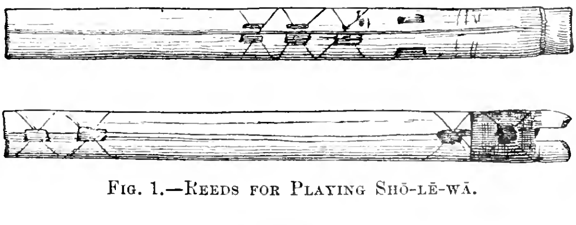

Fig. 1.—Reeds for Playing Shō-lē-wā.

tirely painted black is called *quin*, the Zuñi for black; the one with one black end, *path-tō*; with two black ends, *kō-ha-kwa*; and the one with a black center, *ath-lu-a*. Fig. 2 shows the manner of holding these pieces when about to play. They are held in the right hand, and thrown up against a suspended blanket and

* Fifth Annual Report of the Bureau of Ethnology.

allowed to fall on another blanket. Two of the pieces belong to each man and are companions. The manner in which the sticks fall determines the result. There is a pool with twelve markers in it, and he who wins the markers wins the game. The winner takes the twelve markers up into his hands and breathes on them. This is because they have been good to him and allowed him to win. It is wholly a game of chance, and horses, guns, saddles, and everything are staked upon the throw.

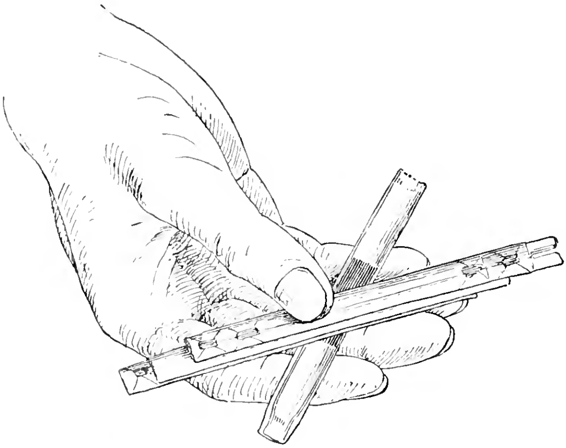

Fig. 2.—Manner of holding the Reeds in Shō-lē-wā.

Tash-a-lē-wā.—This is a game of chance, is played by two, and is very popular. The players sit on the ground, with a ring of forty small stones, in four sections of ten stones each, between them. The ring is usually several feet in diameter. In the center is a large flat stone called *a-rey-ley*, upon which the players make their throws. The dice, *ta-mey*, are small flat sticks about three inches long, and painted red on one side. These are taken in the right hand and thrown endwise on the central stone. If the three red sides turn up, the player scores ten and gets another throw; if the three white sides, he gets five; two red and one white, three; two white and one red, two. For counting, each player has a stick called a horse, or *touche*. Starting from the same interval in the circle of stones, each player moves his marker over as many stones as he has won points. Should the two meet at the same interval, the second one coming there will send the first one back home, and he must begin over. The idea, as given by the Indians, is, that the new-comer has dismounted or killed the first one. The horse is supposed to stop and drink at the intervals between the groups of stones. One game which I witnessed had loaded rifle-cartridges for stakes. Each player places his bet within the circle of stones.

*Ti-kwa-we, or Game of the Kicked Stick.**—This is the great

* This game was described by Mr. F. Webb Hodge, in the Anthropologist for July, 1890. I have thought well to repeat it here in connection with the other games, and also to make some corrections and add several points which Mr. Hodge seems to have overlooked.

national game of Zuñi. Among Zuñi sports it ranks as base-ball does among our own. It is indulged in by almost the whole male population, from boys of five or six to men of forty. Any evening of the summer one can see crowds of twenty or thirty boys skirting the southern hills and kicking the stick. Practiced thus during eight months of the year, they have an especial occasion when they contest for the championship, and this is one of the great jubilees of the tribe. Although the women do not take part, yet they show equal interest with the men and become as much excited.

The time of holding this contest is usually in the spring between the planting of the wheat and the corn. The Priest of the Bow makes six prayer-plumes and six race-sticks. The prayer-plumes consist of small sticks with the white feathers from the tail of a certain species of hawk tied to one side; the race-sticks are about the size of the middle finger. The priest then takes these sticks and places them on the trail toward the south, and for four days they remain there untouched. At the end of this time he, and any others who wish to join in the race, will run out to where the sticks have been placed, and as they arrive they breathe on their hands and then kick the sticks home, making a circle of two or three miles.

Four days later a representative of each clan, each with a picture of his clan painted on his back, will run out in much the same manner. By this time most of the people have returned from their wheat-planting and the *ti-kwa-we* is in order. At present there are six *estufas* in Zuñi—*Ha-e-que, Ha-cher-per-que, Choo-per-que, Moo-ha-que, O-ha-que*, and *Uts-ann-que*. The contest lies between the members of these different *estufas*, and not between the members of the different clans or parts of the pueblo, as has been stated by some writers.

Whatever *estufas* wish to contest select their men. When the men have been selected it is announced in the evening from the house-tops. This generally takes place three or four days prior to the race. This race is generally held at Zuñi, but may be held at one of the farming pueblos, as Pescado, Ojo Caliente, or Nutria; in any case it is *estufa* against *estufa*. On the evening of the day before the race each side sends for a Priest of the Bow. Upon arrival he puts into the mouth of each one a piece of glass about one inch long; and with some sacred meal, taken from his pouch, he paints a mask on each one's face, then blesses them, and they repair to the hills three or four miles distant. They depart in absolute silence. Not a word may they speak unless they hear or frighten some wild animal in front of them. If the sound comes from behind, it is considered an ill omen. Having reached the hills, they dig a hole about the length of the arm and deposit in it some sacred meal, native tobacco, *hewe*, shells, and other things held valuable by the Zuñis, and then retire a short distance and do not speak above a whisper. In a little while one will start for the pueblo, saying nothing, and the rest follow in single file. As they return, any manifestation of power, as thunder or lightning, is considered a good omen, as it will make them strong.

The priest who blessed them before they started awaits their return and accompanies them to the house of one of the racers or that of any member of the same *estufa*. As they reach the door of the house, those within say, "Have you come?" "We have," they reply. "Come in and sit down." The priest then blesses them, and a single cigarette is made of native tobacco and passed among the number. Then they retire for the night. Next morning everything is alive in Zuñi. Indeed, for several days past the whole population has been somewhat excited over the coming event. Every one takes sides, from the gray-haired old warrior, who believes the *ti-kwa-we* to be the greatest game ever held, to the blushing maiden whose lover is one of the contestants. Excitement runs high, and the gambling disposition of the Indian has its fullest encouragement. The small boy meets his playmate and stakes all his possessions. The veteran gambler once more tries the turn of fortune, and to counteract his heavier betting he makes a longer prayer to Ah-ai-u-ta or plants an additional plume. The contestants themselves engage in betting, and every conceivable thing of value to an Indian is either carried to the plaza, south of the old Spanish church, where it is put up against something of equal value held by an opponent, or is hurried off to the trader's store and turned into money. Ponies, sheep, goats, money, beads, bracelets, all are wagered. Sometimes also they sell the race. This is not generally admitted by the Zuñis, but I have it on good authority that it has been done.

The day for the race has arrived; the runners have been up since early morning, and have taken a spin over part of the course. During the morning nearly all the members of the *estufa* drop in to tell them how much they have wagered on their success and to encourage them. About an hour before the time to start they eat a little *hewe*, or paper bread, soaked in water. *Hewe* is one of the chief breadstuffs of the Zuñis, and a good *hewe*-maker is in reputation throughout the tribe as a good pastry-cook is among us. *Hewe* is made from corn batter spread with the hand on a large flat stone over a slow fire. It takes but a moment to bake it, is almost as thin as paper, very crisp, and will vary in color according to the color of the corn used. This repast of *hewe* is accompanied by a piece of humming-bird, as the flight of that bird is so very swift.

The runners then bathe in a solution made from a root called *que-me-way*. The time for the contest is at hand. The every-day attire is exchanged for the simple breech-clout. The hair is done up in a neat knot on the top of the head, and the priest pronounces a blessing as he fastens in it an arrow-point, the emblem of fleetness. He then places a pinch of ashes in front of each racer, and, standing before him, holding an eagle-wing in each hand, he first touches the ashes with the tips of the wings and then brushes the racer from head to foot. Then turning to the north he touches the wings together and says a prayer, the same to the west, south, east, the earth, and sky. I suppose the idea of the Zuñi in this to be, that as he has sent a prayer to the four points of the compass, the earth, and sky, he has cut off every possible source of misfortune and danger.

Everything being now ready, the priest leads his favorites to the course across the river. Excitement in the pueblo has reached its height; the most venturesome are offering big odds in the plaza, and now all assemble to see the start.

Should a side be at all doubtful of its success in the race, an old woman is procured to sit and pray during the entire race. She sits in the middle of the room. The racers sweep the floor around her and then pile up everything that is used about the fire, such as pokers, ladles, stirring-sticks, and even the stones used to support the pots during cooking: these are to make their opponents warm; also the mullers with which they grind the corn, and the brooms: these will make them tired. A woman is chosen rather than a man, because she is not so fleet of foot. Similar ideas are found among many other peoples.

"It is a world-wide superstition that by injuring the footprints you injure the feet that made them. Thus, in Mecklenburg it is thought that if you thrust a nail into a man's footprints the man will go lame. The Australian blacks held exactly the same view. 'Seeing a Tatūngolūng very lame,' says Mr. Howitt, 'I asked him what was the matter? He said, "Some fellow has put bottle in my foot." . . .' The Damaras of South Africa take earth from the footprints of a lion and then throw it on the tracks of an enemy, with the wish, 'May the lion kill you!'" *

As each side is brought to the course the priest gives a parting blessing, and the runners take their positions opposite their opponents in single file along the course. The *tik-wa*, or stick to be kicked, is about the size of the middle finger. That belonging to one side has its ends painted red and that of the other side its center painted red, so they may be easily distinguished. The rear man of each file places the *tik-wa* across the base of his toes and sprinkles a little sacred meal upon it. Surrounding the racers

* J. G. Frazer, in Folk Lore, June, 1890.

will be three or four hundred mounted Indians dressed in the gayest colors. All is now ready; each rider has his eye on his favorite side, an old priest rides in advance and sprinkles sacred meal over the course, the starters kick the sticks, and the wildest excitement prevails. As each racer left his home he put into his mouth two shell beads—the one he drops as a sacrifice as he starts, the other when he has covered about one half the course. The stick is tossed rather than kicked, and a good racer will toss it from eighty to one hundred feet. Over the heads of the runners it goes and falls beyond the first man. He simply points to where it lights, and runs on. The next man tries to kick it, but should he fail to get under it he goes on, and the next man takes it. The race is not to the swift alone, although this has much to do with it. The stick can in no case be touched with anything but the foot, and should it fall into a cactus bush, a prairie-dog hole, or an *arroyo*, much valuable time is lost in getting it out. Not infrequently it happens that one side will be several miles in advance of the other when the stick falls into some unnoticed hole. The wild and frenzied yelling which takes place as those who were behind come up and pass can only be imagined and not described. So skill in tossing it plays a prominent part. On, on they go to the southern hills, east to Ta-ai-yal-lo-ne, north to the *mesas*, follow these west for miles, then to the southern hills, and back again to the starting-point. The distance traversed is nearly twenty-five miles, and they pass over it in about two hours. Racing is indulged in by the excited horsemen as they approach the goal, and it is not unusual to see a pony drop over dead from exhaustion as they near the village. The successful runner crosses the river and runs around the heap of wagered goods near the church, then, taking up the *tik-wa* in his hands for the first time, he inhales, as he thinks, the spirit of the *tik-wa*, and thanks it for being so good to him. He then runs to his home, and, if he finds a woman awaiting him, hands the stick to her, who breathes on it twice, and he then does the same. Returning it to the woman, she places it in a basket which she has ready for it; and the next day one of the racers wraps it up with some sacred meal in a corn-husk and deposits it about six inches below the surface of the ground in an *arroyo*, where it will be washed away by the rains.* Meanwhile the winners have claimed their stakes, and, should another *estufa* have a set of men to put up, the winners of the first race must compete with them until all have had a chance, and the great Zuñi races are over for that year.

* This reminds one of our custom of burying certain things under the drop of the house, or throwing them in streams, for the purpose of curing certain diseases. To-day the Zuñian plants his prayer-plumes in the water-courses. Can it be that our custom had a religious origin?

Kle-tak-wa (*Rabbit-hunt*).—Communal hunts seem at one time to have been held by many of the Indian tribes, and are described by the early Spaniards. Many of them were nothing less than a wholesale slaughter. Whether the Zuñis ever indulged in them to that extent I am unable to say, but I saw a fence about fifteen miles to the southeast of Zuñi which, I was told, extended for seventy-five miles, and was formerly used to direct the herds of antelope to a certain place. The presence of the fence suggests the possibility that formerly such hunting expeditions may have taken place there, as Livingstone describes in southern Africa. The rabbit-hunts are described by the early Spanish chroniclers, and are still held by at least the Zuñis and Moquis. Undoubtedly at one time they had a considerable religious significance, but to-day they have more the nature of a frolic.

The Zuñis have eight rabbit-hunts a year—four by the Coyote people and four by the Eagle people. The time of holding them is fixed by the chief of the rabbit-hunts. Although held under the especial direction of particular clans, yet nearly all the male inhabitants take part. I will describe the one in which I took part last August.

Fig. 3.—The Start for the Rabbit-hunt.

One evening about sundown I heard the herald (as is the custom of this people) announcing something from the top of the pueblo. Upon inquiry, I learned that there would be a rabbit-hunt in four days. Three evenings later, seated upon the top of the pueblo, as was our wont to do, while watching the gorgeous sunsets, we noticed that, in addition to the accustomed scene of home-returning flocks and herds, there were many herds of Indian ponies brought in and put into the *corrals*. This foretold a good turnout for the morrow. Just at nightfall the herald again proclaimed the hunt. At noon the next day the scene in the pueblo was an active one. Everywhere ponies and horses were being saddled for the chase. Some few who had no ponies started ahead on foot. Half an hour later we all gathered on the farther side of the river, on the road to Ojo Caliente, and a picturesque crowd it was indeed—between three hundred and four hundred horsemen dressed in calico of all colors and patterns, with all kinds of head-gear, from the *sombrero* decorated with eagle-feathers to the scarlet head-band. A few had bows and arrows, others had hoes and digging-irons; but all had two or more boomerangs, called *kle-a-ne*— simply curved sticks about eighteen inches long.* These they use to kill the rabbits, being thrown from the horse while in motion. A few Navajoes, who also took part, added to the scene. The hunting ground was about ten miles to the southwest, on the road to Ojo Caliente. It is generally customary to have a *ti-kwa-we* on the way down. So far as I could see, no betting was done, but the excitement at times was intense. There were four racers on a side, and the course was covered in very good time.

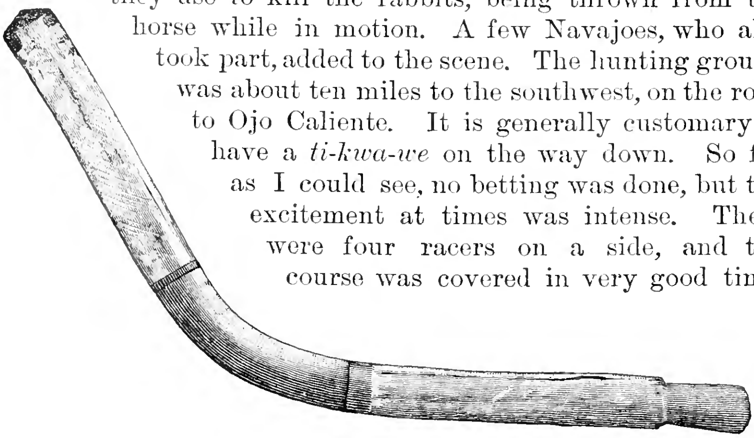

Fig. 4.—Moqui Boomerang.

As the word was given to start, the company spread out over about an acre of ground, with the racers in the center. Each horseman cheered his side, and when the race was over I procured the *ti-kwa*. When we reached the ground, already the Cacique of the Sun had lighted a fire, and I was told he had put under it medicine to make the rabbits slow. This belief in the power to thus control wild animals is held by other peoples.

"This superstition is turned to account by hunters in many parts of the world for the purpose of running down game. Thus

* Fig. 4 represents a Moqui boomerang. Those used by the Zuñis on the rabbit-hunt were much the same, only not quite so well made, a stick with a less marked curve serving in most cases. They were thrown as clubs, with elbow forward.

a German huntsman will stick a nail taken from a coffin into the fresh spoor of the animal he is hunting, believing that this will prevent the quarry from leaving the hunting ground. Australian blacks put hot embers in the tracks of the animals they are pursuing. Hottentot hunters throw into the air a handful of sand taken from the footprints of the game, believing that will bring them down." *

The second priest of the Order of the Bow made a long speech, in which he told the hunters that the rabbits had been made slow, and they should get ready for the chase. After the ponies had rested a little, all mounted and set out. The more devout, however, before starting, went up near the fire, dismounted, untied their boomerangs, and got out a piece of bread. Advancing to the fire, they first said a prayer, then held their boomerangs in the flame or smoke a moment, and then threw a piece of bread into the fire as a sacrifice. Others dismounted and, without saying a prayer or offering any bread, just passed their boomerangs through the flame and remounted; while others only rode near the fire and, without dismounting, simply waved their sticks toward the flame and went on. The great majority, however, did not come near the fire at all. As I witnessed this feature of the hunt, I could not help silently observing that among the Indians there are degrees of devoutness as among white men.

The Priest of the Bow made a second and a third speech, and by this time the horsemen were well scattered over the plain. This was covered with sage-brush and scrub cedars. There are two species of rabbit, the cotton-tail (*ok-she-ko*) and the jack-rabbit (*pok-ya*). There was no attempt to surround a large territory and drive the rabbits; but, as one was started up, his pursuer would give a yell, and in a few moments the harmless cotton-tail or jack would be surrounded by fifty or sixty horsemen. As they close in on the rabbit, those nearest it throw their boomerangs, and whoever hits it is off in a moment to claim and pick up his game. If the rabbit is not already dead, it is at once dispatched by a blow with the hand, and then it is raised to the mouth, and the hunter inhales, believing he is taking in the spirit of the rabbit. He then ties it to his saddle, and is ready for another chase. The cotton-tail often takes refuge in a hole, and then there is a grand rush to the place to reach in and pull it out. Grubbing-hoes, digging-irons, and fingers are all used to enlarge the hole, and at last the poor rabbit is pulled out, with perhaps only half his hide on. Thus it was, for three or four hours, just a succession of rallies and deploys. At the end of that time nearly every one had one or two rabbits. Those on foot seemed to fare as well as those on horseback. I am told that

* J. G. Frazer, in Folk Lore, June, 1890.

sometimes they bring in wild cats and coyotes, caught in the same way, but they found none that afternoon.

About six o'clock a heavy shower came up, and the foresight of the Indian at once showed itself, for every one of them had his blanket with him, while I was thoroughly drenched. As we returned to the pueblo, many feats of horsemanship were displayed and a number of races run.

The rabbits are given by the hunters to the squaws, who place them on the floor of the house, with an ear of corn between their paws. Bandelier tells us that formerly these hunts were conducted in behalf of the caciques of the tribe, but this custom seems to have fallen into entire disuse.*

AN EXPERIMENT IN MORAL TRAINING.

By Dr. MARY V. LEE.

WHILE waiting in a corridor of the Oswego Normal School building, forty or fifty lads and lasses from the practice school marched in quadruple column past me. They were full of life, observant, unaccompanied by teacher, but attending to the duty of the moment in an orderly manner. The company separated, each division passing to its own room. After a brief interval I followed the band, made up of boys and girls from fourteen to sixteen years of age. I found them conversing with their principal in such manner as induced me to tarry. The experiences of that hour seem so full of meaning as to deserve record and emphasis.

Evidently the pupils were for the time unconscious that the gentleman before them was vested with authority; evidently it was his purpose to show no authority, but to talk with the children as heart to heart, as man to man. Freedom, earnestness, and sincerity characterized the interview; in fact, the spirit of the room constantly suggested, "Come, let us reason together."

Below I give a free reproduction of that which I saw and heard:

Teacher. Several weeks ago I left a question for you to think about. What was it? (Each pupil raised his hand thoughtfully, and the teacher indicated who might respond.)

Pupil. You asked how many of us were willing to have those pupils who hinder the work of the class removed from it.

Teacher. Yes. How many have decided? (Each of the nineteen pupils raised the hand.) How have you decided, Henry?

* Ad. Bandelier, Papers of the Archæological Institute of America. American Series, iii, p. 160.

Henry. I am willing.

Teacher. How many are willing? (All but the largest lad signified their willingness.) Why are you not willing, John?

John. I do not think the boys have had a fair chance. (I then became aware that two boys belonging to the class were absent. During the remainder of the lesson these boys, whom we will call Frank and Ward, were frequently referred to by name.)

Teacher. What do you mean? You know I have spoken to them repeatedly. They know they hinder the progress of the class by their conduct. How have they not had a chance?

John. I don't believe any of *us* have talked with Frank and Ward.

Teacher. How many have spoken to them about their conduct? (Not one hand raised.) How many have done anything to signify disapproval of it? (One of the older girls, with serious and even anxious expression, raised her hand.) What have you to say, Mary?

Mary. I have not *spoken* to the boys, but the other day when Ward was doing wrong I shook my finger at him like this.

Fanny. I have not spoken, but I have shaken my head at Frank.

Teacher. Two out of nineteen have expressed disapproval of conduct which interrupts the work of our class. I am glad two have tried to help by the warning hand and the warning head. It is a question of the removal of Frank and Ward from this class, where they hinder, to a room where they may learn to be helpers—may learn by more severe measures than we use here to control themselves. Only one in this class has been sent to that room; he may tell us if being placed in it helped him. (The lad referred to rose and stated frankly that he had been helped by being in the room named.)

Teacher. For whose good would Frank and Ward be put in that room?

Pupils. Theirs and ours.

Teacher. Yes. Then why not vote to place them there?

John. I think the class ought to try to persuade them to do better before they are sent away.

Teacher. So do I. I saw a policeman step up to a disorderly man on the street, put his hand on his shoulder, and quietly say: "You better go on, better go home; if I find you doing this again, I shall have to gather you in." The policeman was giving friendly warning to the man. How many of you are willing to warn Frank and Ward? How many are willing to talk to them about their wrong-doing? (All hands but John's raised.)

Teacher. How is this, John? You are not willing to have the boys taken from the class, and you are not willing to talk to them.

John. You see, Mr. Norton, I am just as bad as they are, and I couldn't speak to them. (Said with much blushing and great openness.)

Teacher. In my school in —— were two boys. No, I must not say *my* school, I must say *our* school, for there we had got on so far that the pupils used to say *our* school. Well, in our school in —— were two boys, Ned and Tom. After Ned had been in the school a year and had grown to be a reliable lad, a great help to us all, the school board in —— voted to take Tom from the school he had been attending and to put him in our school. Tom's father came to see me, and I asked him to tell me about his son. This is what that father—he was a lawyer and a judge—said: "Mr. Norton, if my boy can have a bull-dog that will chew up every dog in this town; if he can own a game-cock that will knock over every game-cock in the city; if he can have a horse that will throw dust in the eyes of every other horse in town, he is happy. But, Mr. Norton, that boy has not a single literary aspiration." I was not particularly anxious to have in our school a boy of whom his own father—and he a judge—gave such an account, but he came without a personal invitation from me. For two days he behaved himself, but the third day he was at his old tricks. Why did he behave himself at first?

Pupils. He didn't know how the new pupils would take him. He was just waiting to see what stuff they were made of.

Teacher. Exactly. He introduced his accomplishments gradually. What do you think his classmates ought to have done when he began to perform?

Pupil. Not look at him.

Teacher. Good. If when he had stood on his head in one corner—I do not mean to say that was his particular *forte*—and had looked up for admiring approval, he had found all the class attending to school-work, if he had then turned his best somersault, but still could catch no eye wandering from the real business of the hour, what do you think he would have done?

Pupils. Stopped his nonsense.

Teacher. Yes, I think so. But those pupils *did* look at Tom occasionally with a certain degree of admiring interest; they had not grown altogether self-controlled. What would be the effect of this attention from the class?

Pupils. Tom would cut up more and more.

Teacher. He did. One day Ned, in a talk with me, said that he and Tom used to be great friends, that they used to make it very interesting for their teachers in the other school; what one could not think of the two could. I asked Ned how it was he had changed, had stopped making it so interesting for the teacher, and had become reliable and attentive to school business. He said:

"Mr. Norton, the boys did it. When I cut up they talked to me, and they kept on talking till I just had to quit my old ways." Then I said to Ned, "Who is going to talk to Tom?" He replied quick as a flash, "Mr. Norton, I never could, for you see Tom and I used to be in the same boat, and if I should talk to Tom he would laugh at me good." I did not ask him to speak to his friend, but I did ask him who would do it and help get him on the up-grade. To make the story short, the outcome was that Ned volunteered to talk to Tom. Tom turned round, and in a year that Tom who had not, according to his own father's statement, a single literary aspiration, elected to enter the academy and go on with his education. Ned did a good work for Tom. Tom was the hardest boy I ever knew who turned right about and set his face toward the top of the hill. I have known worse boys whose faces were always toward the foot of the hill.

(During the preceding narrative the class was an engaging sight. Their faces, grave at first, broadened. The little chap who had got good in "*that room*" expanded till he covered all that part of his desk separating him from Mr. Norton; he put his head on his outspread arms and opened every avenue to the reception of information regarding the boys who made it *very interesting* for their teachers. Suppressed chuckles showed his admiration for Mr. Norton's word-pictures of boys. Even Mary smiled protestingly. In Ned's relation to Tom, John saw his to Ward and Frank; the sense of his obligation to them grew stronger, and finally he screwed his courage up to volunteering to promise to do his duty and talk to them when they disturbed the class.)

Teacher. I know it is not always easy to speak to a friend who is doing wrong. One has to deny one's self for others. I visited a home a while ago in which were father, mother, three sons, and two daughters. There was a small salary and a little farm. The boys were to be sent to college—two were there. All the nicest fruit on the farm, the best vegetables, the cream were sold, and the family lived on the plainest food, that the boys might be educated. The father wore old clothes except when he preached. The mother had no nice dresses, she worked hard, her hands were not pretty, and her face was full of wrinkles. The father and mother were always denying themselves every luxury and many comforts for their children. Do you suppose they gained anything because they denied themselves?

Pupils. They grew good. They grew generous. They would have their reward.

Teacher. Yes, patience, fortitude, love, goodness showed in the faces of that father and mother. A reward comes to any one who denies himself through love of another; he is not just the same after the denial; he is better and stronger.

At this point I was called from the room, but I learned that each member of the class promised to do his duty by Ward and Frank if they remained in the class. I learned that these boys were told by Mr. Norton that their class voted to retain them. The boys promised to try to do their duty. Mr. Norton told them that boys reported that they had a good time when they talked with him in his office. He was glad they had a good time, he also enjoyed it; but now that they had given their word of honor to try to do their duty, he thought he ought to have evidence that there had been more than a good time. "What shall we do, Mr. Norton?" "Anything you like." The boys conferred, then wrote and signed a promise, which they gave their principal and *asked* him to read to their mates that they might know that they were in earnest. After this they were returned to their room, which is in charge of an apprentice or practice teacher.

A few days after I visited the class and found Frank and Ward doing well. Later they relapsed somewhat. During this relapse I met Mr. Norton and reported it to him. He smiled hopefully and said: "Young persons do not move steadily toward the desired haven; they drift, adverse winds sweep over them; in fact, their progress is very similar to that of adults. I do not ask how far on the way my pupils are, but which way they are tending. Frank and Ward are tending toward the haven. I will see them, ask them how they are doing, encourage where I can, remind them of their promissory note in my pocket, warn them if I must. We are on the up-grade. Character-building is a slow process; have you not found it so in your own case?" "Yes," was my reply. "But, Mr. Norton, why do children so hate to go into *that* room, so hate to vote to have their mates go there when they frankly say it is for the good of the pupils who go, and for the class relieved for a time of their presence?"

"Because they are coming to appreciate character, to admire the person who can govern himself. They see a difference between the men in prison who do not use whisky because they can not get it, and the men outside who do not use it because they *will* not. They are feeling the dignity of freedom and the responsibility that accompanies it. They look upon their class-room as a place where the pupil is free—free to do his own choosing. When he shows by persistent wrong-doing that he can not be trusted to choose, he goes to 'that room' where another chooses for him and enforces his choice, if need be, by the use of the rod. The more strength for right choice the pupils get, the more reluctant they are to vote their mates destitute of power or determination to choose wisely, which they do when they banish them to that room."

I believe lessons like the one recorded are unusual. The points which seem to deserve emphasis are—the freedom and sincerity of the pupils, their entire lack of antagonism to such discussion, their clear perception of the facts in the case and of the relations of cause and effect, their acknowledgment of their duty and their resolve to do it. While there was reference to the conduct of Ward and Frank, the discussion mainly related to their own duties and responsibilities.

Being acquainted with the average youth of the age of these pupils, I saw that the conversation I had heard was the latest of many. The freedom, the seriousness, the consideration for others, and the final decision to help, indicated that this class had passed beyond the primary grade in morals.

Another thing was impressive: These pupils were helped to a correct emotion regarding duty, but the matter did not end in emotion; they were immediately and purposely so circumstanced as to have continual opportunity to decide in accord with their ideals of right or to decide against it. Further, it was evidently Mr. Norton's plan to show the pupil his own good purpose whenever he seriously failed to execute it, and to inspire him again with hope and decision.

Is not this class in the practice department of the Oswego Normal School getting moral *training*, not simply moral instruction? Might we not indulge in cheering visions of the citizens our schools might rear were all our children getting similar training? Give us a century of such work in our schools, and such an article as that on Education and Crime, in the Monthly. would be a curiosity

Note.—To-day, November 21st, nearly a month after the preceding was written, the practice teacher in charge of the class before considered reports that Frank is daily improving, but that Ward is still an annoying lad. "But," said she, "a glorious thing happened to-day. The pupils were hard at work, with the exception of Ward, who was very troublesome, when Frank gave him a stern rebuke and then returned to his lesson. So you see Frank is growing in self-control and in desire to help in our little community."

In the old silver mines of Pribram, in Bohemia, there are several vertical shafts exceeding 900 metres in depth. The shaft Saint Prokop is 909 metres; Saint Anne, 942 metres; Francis Joseph, 992 metres; Saint Adelbert, 1,099 metres; and Holy Virgin, 1,116 metres deep. Subterranean observatories have been established in the thirty-second stories of the two deepest shafts, for the notation of variations of temperature and magnetic deviations. The rocks of central Bohemia belong to the Silurian system, and these two shafts are certainly the deepest vertical shafts in hard rock in existence. Besides silver and other precious metals, more than eighty species of minerals, some of them very rare, have been found here. This makes Pribram one of the most remarkable mineralogical locations on the globe.

PROFESSOR HUXLEY ON THE WAR-PATH.

By the DUKE OF ARGYLL.

II.

[*Concluded.*]

BUT now—if Nature has indeed never stopped her operations at any one time—if they have been, on the contrary, always continuous in unity of plan amid every change in method, then it follows that we do not know how often new germs may have been introduced and may have had their full development accelerated by processes of comparatively short duration. Darwin, in a passage but little noted, has thought of this. He speaks of stages of development being possibly "hurried through."* We see this actually done in the living world, although we do not often think of it as we ought. It is done in all the mysterious phenomena of metamorphosis. A comparatively low and simple organism goes to sleep, and in a few weeks—or a few days, or even, it may be, in a few hours—it awakes entirely reformed, reconstructed, provided with new organs, and fitted for absolutely new spheres of activity and life. We do not know whether this method of creation may not have been repeated over and over again with abiogenic germs—just as it is now repeated in an infinite variety of forms among the germs which are biogenic. I am contending now for a true and honest agnosticism and not for any theory. We do not know that inheritance by descent is the only possible or the only actual cause of likeness and homologies in organic structure. It is not the cause of it as regards the inorganic world, and it may not be the only cause of it in those houses which have been made out of inorganic materials to be the abodes of life. It is indeed not possible that inheritance can be the only cause of likeness—if it be granted that the first starting-point of development must have been in germs which had no organic parent. On the other hand, we can be quite certain of the reason why organs should be made like each other, although we can not be sure of the physical causes through which exclusively this likeness must be brought about. The reason is that certain needs must be met by appropriate apparatuses—vital, chemical, and mechanical. Extraneous matter must be assimilated, weight must be supported, circulating fluids must be supplied with oxygen, light must be caught upon adapted surfaces, and must be transmitted through focused lenses, if sight is to be enjoyed. And so on. The Why is within our knowledge. The How is most doubtful and most obscure. Geology, above all other sciences,

* Origin of Species, sixth edition, p. 149.

impresses this ignorance upon us—even as regards some of the simplest of her operations. Sometimes it is difficult to understand the conditions of original deposit. Very often it is still more difficult to understand the conditions of denudation or removal. The great earth-movements which have certainly taken place are full of mystery—the depressions and elevations, the cracks and "faults" which have dislocated the strata, the "downthrows," sometimes of thousands of feet, which have cut across the rocks as sharply as if the cutting had been effected by a knife, the overthrows and the overthrusts, the sinkings and the underthrusts, which have inverted the order of original formation, the metamorphism which has obliterated original structure here, and has left it wholly unaltered there; the vast thicknesses which are destitute of the remains of life, in juxtaposition perhaps with some one thin bed which is crowded with them; the methods by which, and the times during which, old forms of life have been destroyed, and new forms have been introduced—all these, and a thousand others, are questions on which our ignorance is profound.

Now, it is a remarkable fact that all these difficulties are, as it were, multiplied and accentuated in that very period which is nearest to us—that period which was marked by the very latest changes of which geology has any cognizance—I refer to the period which is now generally called Quaternary. It is sharply marked off from previous periods by a strictly scientific definition. Shells, and particularly marine shells, may be called the time-medals of creation. Their comparative indestructibility, and the fact that the element in which their inmates live is the same element which preserves their habitations when they die, make it certain that in them Geology keeps her oldest, most complete, and most authentic record. The Quaternary period is defined as that during which innovation was stopped as regards the development of shell-life—during which no new species was born—during which we find, with a few rare exceptions, no shell which is not also an existing and a living species. As regards them, therefore, the Quaternary period is the existing period in the classifications of geology. It is the age in which we ourselves are now living. And yet this is the very period during which the greatest novelty of all seems to have been introduced, for it is in this period that we can first detect the advent of man. Moreover, it is in this period that there seem to have been some of the most mysterious earth-movements of which the science has any glimpse. Great dislocations of strata—great changes in the distribution of land and sea—great destruction of preceding forms of life, are among the familiar conceptions which its best-ascertained phenomena suggest. Nor is this all. The vanishing of preceding forms of life in many older periods may have been gradual, and the creatures which disappeared may be supposed to have lived on in their modified descendants. But in our own Quaternary period multitudes of the vanishing beasts seem to have been destroyed by some great destruction, many of them leaving no descendants whatever to represent their antique and abandoned forms. Nature has simply obliterated them altogether. All these circumstances, and many more, combine to make this present geological period in which we are still living—the Quaternary period—one of the darkest and most mysterious of all. Thus every possible question which is the most difficult in geology seems crowded and aggregated into the age which stands nearest to us, and to which geologically we ourselves belong.

If, then, there is any one of the halls of science into which we should enter with uncovered heads, it is surely that in which the grand problems of Quaternary geology are handled and discussed. If in her great temple there be any pavement on which a true and wise agnosticism would tread with cautious and humble steps, it is upon that which constitutes the threshold of inquiries so complicated as to facts, so difficult as regards the interpretation of them, and so profound in their bearing upon other subjects of the very highest interest and importance. Yet this is the threshold across which Prof. Huxley comes tripping on the light fantastic toe. It would be hard to say whether his utterances are most conspicuous for their dogmatism or for their levity. All agnosticism is forgotten, and all sense of ignorance is denied or silenced. After pouring out the vials of his wrath and expending the arrows of his ridicule on a conception of the Deluge which nobody entertains, he turns fiercely on a German author who has ventured to suggest that some catastrophe greater than any mere floods of the Euphrates and of the Tigris may possibly have happened among the many and obscure changes recorded in Quaternary geology. Prof. Huxley seems very anxious to get this idea out of his way. He won't hear of it. He knows all about it, at least for the purposes of denial. He does not argue the question. He does not give any reasons. He simply denies the possibility as of his own authority, and pronounces it to be "particularly absurd." This attempt to settle by an *ipse dixit* what can and what can not possibly have happened during the great physical changes of the Quaternary age, will never do. Even if it were only on account of our utter ignorance of all details respecting those changes, that ignorance is notorious enough to condemn such an attempt as an offense against all the legitimate methods of science.

But there is worse than this in the sentences which follow. Prof. Huxley declares contemptuously that the occurrence of any catastrophe during the Quaternary age, such as could give rise to the traditions of a deluge, is an "hypothesis which involves only the trifle of a physical revolution of which geology knows nothing." Now here we have a positive assertion; and it is one which can only be met by a contradiction as direct and flat as truth demands, and as the courtesies of literature will allow. Once upon a time in discussion with an illustrious and venerable man, Prof. Huxley felt called upon to say that his opponents' assertions were "demonstrably contrary to fact."* I may safely assume, therefore, that this is a form recognized by the highest authority as occasionally required even in the calm and lofty debates of science. This, accordingly, is the form of contradiction which I now venture to adopt in meeting the confident assertion of Prof. Huxley. I do so, however, declaring emphatically that I have no suspicion whatever that Prof. Huxley intended to deceive anybody, whether himself or others. All that I am sure of is that if others believe what he says on this matter they will be deceived, and deceived grossly. The explanation lies in the fact that, in the hot pursuit of his theological antipathies, he has made the very simple and natural mistake of confounding "geology" with himself. But these two are not identical or convertible terms. He may not have seen—because prejudice has shut his eyes—some things which geology has seen, and seen very clearly too. He may not know of, or recognize the full import of, facts which geology does know of, and has established. But whether he knows of them or not—whether he has ever "put two and two together" in respect to them—it does so happen that among the difficult problems of Quaternary geology, three great salient conclusions have been established. The first is, that among the very last and latest changes in the history of the globe there was a great extension to the south of the conditions of climate which are known as glacial. The second is, that during part of that time—and almost certainly during the very last part of it—or even since it ended—there was, over some great part at least of the northern hemisphere, a great submergence of the land under the waters of the sea.† The third is that man had already appeared upon the earth, and had more or less spread upon it, before that late submergence took place, and must, therefore, have been a witness, and may possibly have been a victim, to it. Now, the first two of these conclusions are not only "known to geology," but are among its most widely accepted doctrines, while the third has made great progress and is rapidly taking—if, indeed, it has not already taken—the same place and rank in the category of discovered and admitted truths.

If, then, these three great facts have acquired this position—and even if they be disputed by a few writers, or by Prof. Huxley

* Comparative Anatomy, p. 98. † Text-Book of Geology, by A. Geikie, p. 891.

himself—it is "demonstrably contrary to fact" to allege that geology "knows nothing" of them. The science knows of them so well and so familiarly that "the last great depression" has become a stock phrase among Quaternary geologists—as referring to many ascertained phenomena which are capable of no other interpretation.

It may, however, be well asked how it is, if these three great facts have been established, that the conclusions flowing from them have not been followed up. The explanation is as easy as it is instructive. It has been due to that one cause which, perhaps more than any other, has impeded the advance of science—the blinding effect of invincible preconceptions. Sometimes these have been aggravated by such intellectual aversions as that which animates Prof. Huxley against everything connected with Christian theology. But many desperate preconceptions have other sources. The authority of great men who have fallen into some great error has been one of the barriers most difficult to breach. Of this kind perhaps the most memorable example was the power of Sir Isaac Newton to postpone for nearly a century and a half the establishment of the undulatory theory of light. The furious and contemptuous attacks made upon Dr. Thomas Young, when in our own day he revived that theory and poured the light of his own genius upon it, remind one very much of the temper and the spirit in which some men are now meeting those movements of discovery that tend to reopen questions which only ignorance had closed, and to give to old ideas a new and scientific basis. Then there has been another source of abounding prejudice. The shape in which those old ideas were at first presented has often been really deforming and erroneous. This has been pre-eminently the case with the form under which the idea of a deluge has come across the pathway of geology. At first men would not believe in the reality of fossil shells. When this reality was proved to demonstration, then the supposition was entertained that they were carried into the solid rocks by the Noachian Deluge. The absurdity of this supposition was almost sickening, and it established a lasting sense of nausea in all the stomachs of geologists at the very mention of a deluge as coming at all within the cognizance of their science. This is just the attitude of mind which sets up the most insuperable preconceptions, and renders men insensible to the force of any evidence which even seems to look in the direction of their disgust. In this very article Prof. Huxley makes a confession upon this subject, which he does not mean as such, but which, nevertheless, is a confession most true and most significant. "At the present time," he says, "it is difficult to persuade serious scientific inquirers to occupy themselves in any way with the Noachian Deluge. They look at you with a smile and a shrug," etc. This is quite true. But it is also true that the attitude of mind thus depicted is most unsafe and most unphilosophical. I confess to having myself lain under the incubus of the same preconceptions for many years. It was of course easy to take refuge in the bolt-hole dug out by Lyell—that if there ever was a deluge it must have been an event so "preternatural" in all its circumstances and effects that there is no use in even thinking of it in connection with any of the physical sciences. Yet the promptings of our intellectual conscience will perforce suggest that, though belief and reason are not coincident in extent, they ought to be coincident in direction, and that physical events of great magnitude, if they happened at all, however preternatural, were presumably brought about by physical agencies which must have left some effects behind them, unless subsequent obliteration has destroyed the evidence. This last alternative was indeed easily conceivable in the abstract. It is, however, always less easily conceivable in each actual case in proportion to the magnitude of the supposed events and the recency of their supposed occurrence. But this method of looking at the whole case, which is purely logical and scientific—this perception of alternatives turning upon evidence, and on the possible causes of the want of any evidence at all—is a method which at once awakens our intelligence to the testimony of facts, and breaks down the stupid preconceptions which blind us to the true interpretation of them. It puts an end to that irrational attitude of the mind which Prof. Huxley, strange to say, seems to approve of and applaud, in which we can hardly be persuaded "to occupy ourselves in any way" with a great problem, and in which we can only look at it "with a smile and a shrug."

Once roused from this paralysis of our reason, we soon find that there are abundant materials on which to exercise its powers. I live in a district of country over the whole of which the evidence of "the great submergence" is as striking as it is ubiquitous. I estimate the depth of it as having been at least two thousand feet. Not less decisive is the evidence that it must have happened among the very latest operations which have been at work upon the globe. Charles Darwin saw this in 1839, when he came to the West Highlands to look at the famous Parallel Roads of Glen Roy. His estimate of the minimum depth of it was at least 1,280 feet. He saw it, and he dwelt upon it with emphasis in the celebrated paper in which he recorded his observations. No one who resides in the low country where the rocks are never seen except in quarries, can have any conception how clear and unmistakable are the proofs of some temporary, and very recent, depression of our land, with almost all its mountains, under the level of the sea. Then comes corroboration after corroboration from every field of

Quaternary geology. For thirty years and more geologists have known, and have been staring helplessly on the fact, that in North Wales one of the hills of the Snowdon range is covered with a marine gravel at a level of 1,130 feet above that of the present sea. They have known the fact that this gravel contains shells in abundance, all of existing species. They have known it, but most of them have been reluctant to "occupy themselves about it in any way." Even in recording it they generally leave it, if not "with a smile and a shrug," at least with a timid and embarrassed glance. Yet nothing in the whole range of their science is more mysterious and instructive than that Moel Trefan top. Old Ocean has been there, and he has been there very lately. He has been there as regards the area and the locality, and he has been there in a passing way, but he has not necessarily been there as regards its existing level. Prof. Huxley tells us that a heaping of the sea over a particular place is a physical impossibility. I quite agree. Then it follows that Moel Trefan must have been sunk under the sea and raised out of it again, all within our existing age. Can the learned professor tell us how wide has been the area of depression in which Moel Trefan was included? Was it contemporaneous or not with a like submergence all over the Highlands of Scotland? And if so, where did it stop? Prof. Prestwich has said that it prevailed over the whole of Ireland, over the whole of Wales, over all the center and north of England, and over the whole of Scotland.* A large part of Russia, and all northern Germany down to Holland, were also included.† And is he certain that it was not wider still, and included larger areas of the whole northern hemisphere? Quaternary geology certainly suggests, even if it does not establish, that it did. Italian geologists of the highest authority report the same facts from Calabria and from Sicily. Gravels with three hundred kinds of existing shells are piled up at elevations 2,400 feet above the Mediterranean. Was Charles Darwin an ignoramus in geology when he recognized exactly the same phenomena on the vast continent of South America? The facts he records respecting the massive marine gravels of Patagonia, the recency of them, and the correlative destruction of the great mammalia, are more astonishing even than the parallel facts in Europe.‡ Are the geologists of Canada deceived when they report similar facts as establishing similar conclusions over the greater part of northern America? If the submergence was local, but the locality was as large at least as the British Islands, how "particularly absurd" is the assumed impossibility of a partial deluge! If it was far wider, then how

* Proceedings of the Royal Society, No. 196, 1879.

† Quarterly Journal of the Geological Society, August, 1887.

‡ Naturalist's Voyage, edition of 1852, pp. 170–176.

absurd also is the denial that it may have been as wide as the whole area occupied by man at some early stage of his dispersion! Further, can he tell us whether this "great submergence" over more than one great area, was balanced or not by any corresponding elevation over some other? And if it was, then can he tell us whether the elevation may not possibly have been a raising of some ocean floor? And if it was, can he assure us that the "fountains of the great deep" did not perforce pour their waters over corresponding areas of the land? Can he tell us how deep the great submergence was, as well as how wide? Above all, can he tell us how slow it was, or how rapid? If he can't tell us any one of these things, or make even a plausible attempt to do so, then he has no right to tell the world that Quaternary geology "knows nothing" of any more adequate basis for the world-wide tradition of a deluge than a flood in Mesopotamia. Quaternary geology is still in great confusion, the prey of extreme theorists, and of many baseless hypotheses. But it is not quite in such a mess as Prof. Huxley would represent it to be. For one thing, it has established "the great submergence" with all its consequences.

But this is not all. When once the scales of preconception and of spurious authority have fallen from our eyes, they are opened to other facts which have been as clearly ascertained, as timidly regarded, and as feebly interpreted. In particular we see the fleshly bodies, and the complete skeletons, and the collected and compacted bones of millions of great animals which have perished—very lately—many without leaving descendants—and have so perished as to be preserved in superficial deposits scattered over many portions of the globe. In my own case, it was the futility of the explanation given of these facts of Quaternary geology by the Lyellian school that first awoke my attention, now many years ago, to the untrustworthiness of the method in which these facts were handled. Nothing that savored of the possibility of "catastrophes" would that school even look at fairly in the face. No idea that would not fit, or could not be squeezed, into their own narrow interpretations of the doctrine of uniformity, could find entrance into minds swathed in the bandages of the great hurdy-gurdy theory. I can not in these pages give, even in abstract, the astonishing facts which Quaternary geology has established respecting the death and preservation of what are called the Pliocene and the Pleistocene mammalia—and this, too, both in the Old and in the New World. They have lately been collected and marshaled with exhaustive research, and with admirable ability, by Mr. Howorth, M. P., in his book on The Mammoth and the Flood. I observe that a most significant silence has been maintained respecting this array of facts and arguments, and that the old-school geologists have found it much more convenient to ignore than to answer it.

Then, lastly, the same observations apply to the abundant evidence which Quaternary geology has supplied that man was living before the mammoth and its compeers were all destroyed. The spirited outline of a living mammoth has been left to us by some incipient Landseer of a not very ancient world. The consequences which are involved in this fact were long evaded—never faced or followed—just as the consequences were long evaded of marine gravels heaped upon the tops or the high flanks of our existing mountains. When palæolithic implements were first discovered, not many years ago, both the religious and the agnostic world were fluttered and excited. The one hoped for, and the other feared, the establishment of some hitherto undreamed-of antiquity for man. Both of them forgot that those old implements have, intellectually as well as physically, a double edge. They may serve to establish the extreme recency of some great convulsion—far more than they tend to prove the extreme antiquity of the creatures affected by it. With an instinctive dread of this alternative, vigorous attempts have been made to treat all implement-bearing gravels as fluviatile—the work of existing rivers and the spoil of existing water-sheds. It has been felt that indefinite drafts might then be drawn upon the bank of time—because the implement-bearing gravels are often at high levels, and existing rivers must have been at work for some indefinite number of ages to cut their way down to the present lower channels. But again these attempts have broken down. Human implements—it is confessed—have now been found abundantly in gravels which must have been at least spread and redistributed not by rivers, but by the sea.* Moreover, it is admitted that the old implement-bearing gravels often exhibit the marks of "tumultuous action." Thus all along the line Quaternary geology has established not only the possibility, but the certainty, of many of those events which Prof. Huxley presumes to denounce as "particularly absurd." Every year is opening up some new vista through the thick clouds which envelop the Quaternary ages. Prof. Prestwich may almost be said to be the father of this geology in England. No one man has done so much for it; no one has been so minute and laborious in research, or so careful and conscientious in reasoning on its facts. The very last result he has arrived at † is the probable discovery of the lowest stratum, or the base bed, of the Quaternary series in England. And what is it? It is a thick bed of marine gravel overlying an old terrestrial surface on which now extinct mam-

* The Great Ice Age, by James Geikie, pp. 505, 506.

† Quarterly Journal of the Geological Society, February, 1890, p. 85.

malia lived, and fed, and were destroyed. This gravel stretches up the valley of the Thames, till it reaches elevations eight hundred and fifty feet above the level of the sea.* It contains pebbles, washed, rolled, and translated all the way from the rocks of the Ardennes. This alone records a depression of the land great enough to swamp, not only the greater part of Europe, but the greater part of the habitations of man all over the globe. Prof. Prestwich expressly connects these gravels with great changes in physical geography, and with the destruction of the older or "Pliocene mammalia."

It is impossible in these pages to treat this subject in detail. I have dealt with it at all—and of necessity in the merest outline—only because the confident assertions of a man so eminent as Prof. Huxley are apt to intimidate young inquirers, and to keep up in their minds the fatal preconceptions of spurious authority. But they should remember that though Prof. Huxley is a distinguished expert in biology in all its branches, including paleontology, he enjoys no similar authority in dynamical or stratigraphical geology. *Ne sutor ultra crepidam.* Still less can he, or indeed any other man, be allowed to browbeat our reason in coming to those conclusions which men of even ordinary understanding are perfectly competent to draw from facts which others have ascertained.

There are many miscellaneous things in Prof. Huxley's article on which I have no space to comment. It reminds me of a witty description once given of a favorite but somewhat barbaric Scotch dish—the boiled head of a sheep—"There's a lot of fine confused feeding upon't." A few of these miscellaneous morsels may be tasted in the mean time. Prof. Huxley makes a very lofty claim for Science. It belongs to her, he tells us, to deal with the problem "of the origin of the present state of the heavens and the earth," and also that of "the origin of man among living things." "The present state" are limiting words which make the claim somewhat ambiguous. "The present state" of the earth certainly belongs to history, and much of it to very recent history indeed; and so with regard to the origin of man, if it be equally limited to his "present state." The present state of the members of the Royal Society would be an inquiry not necessarily leading us very far into the past. But if the "origin of their species among living beings" be intended, then science has hitherto offered no suggestion, except that they are all descendants from "some arboreal creature with pointed ears." Science has a good deal to do yet if the task assigned to her by Prof. Huxley is ever to be completed. Another boast goes very near to the assertion that to sci-

* Quarterly Journal of the Geological Society, May, 1890, p. 140.

ence belongs the power of deciding whether there are any agencies in the spiritual, which can produce effects upon the material, world. I suppose we shall be told presently that science can decide, by the microscope and the dissecting needle, whether the Sadducee was right in denying either angel or spirit, and the Pharisee was a fool in confessing both. Our agnostic professor may well be happy in the prospect of such unbounded knowledge being obtained by such simple means.

Then we have a very lofty boast about the hopeless position of Christian divines "raked by the fatal weapons of precision with which the *enfants perdus* of the advancing forces of science are armed." We are tempted to ask if Prof. Huxley himself is one of these "enfants." If so, he must have laid down his arms before he fired off this article. Anything less like a weapon of precision than that which he has shouldered in the fight, it is impossible to conceive. "Old Brown Bess"—with its clumsy bullet, its devious flight, its low penetration, and its enormous windage—is indeed almost a weapon of precision in comparison with that which Prof. Huxley here flourishes against the massive foundations of Christian belief. But, perhaps, he means rather the small arms of the modern critical school. If he does, then precision is the very last characteristic which belongs to it. Its methods are largely subjective. Here and there it may have a clearly ascertained fact to rest upon. Here and there it may have arrived at some tolerably secure results. But in the main its methods are metaphysical, resting on nothing but individual preconceptions, applying tests and private canons of interpretation which are purely arbitrary. There is no credulity like that which leads the agnostic to swallow with open mouth everything that issues from that most copious fountain of fads and follies—the inner consciousness of a German professor.

The assumption which inspires the tone of Prof. Huxley's language on this subject—that precision in research is undermining the credit of the Hebrew Scriptures—is an assumption almost comically at variance with fact. There is, in particular, one weapon of precision which has been of late working wonders in precisely the opposite direction. That weapon is the spade. And what has it been unearthing? Everywhere over that narrow strip of our planet on which its human interests have been most impressive and profound—everywhere from Tyre and Sidon—from Carmel and Lebanon—on the west, to Babylon and Nineveh and the boundary mountains of Assyria, on the east—the spade has been disentombing continuous and triumphant proof of the genuine antiquity and historical character of the Jewish books. Out of them comes the light which guides the explorer; and out of them shines the light which is reflected from his spoils. They give the true and only key to the earliest partings of our race. They are true to the rise and progress of divided nations. The picture of manners which they present is not less faithful than the account they give of early habits and pursuits both in peace and war. Only the other day Mr. Flinders Petrie* has told us how the spade has uncovered those impregnable walls of the Amorite cities which were reported to invading Israel by the spies of Moses. They are found to be more than twenty-eight feet thick at the base—fit to support a superstructure of at least fifty feet in height. There will come, I suppose, our wonderful agnostic critic to point out that the record in Deuteronomy says that these cities were "walled up to heaven."† But these walls of Lachish could never have reached the Pleiades. They could not have so much as touched the moon. Nay, it is certain that they could not have approached even the limits of our own atmosphere. Therefore the book of Deuteronomy is unhistorical, and Christian theology is founded on the "quicksands of fable"!

But the spade, as a true weapon of precision, has done more for us than this. It has revealed to our living sight, in the remains of Nineveh and of Babylon, all the mysterious imagery of the prophets, and all the literal historic truth of their tremendous denunciations. It has revealed in numberless inscriptions‡ the shameless confession of that inordinate pride and cruelty which dictated the policy, and the desolating deeds, of the great military monarchies of the East. It has explained their fall and their own subsequent retributive desolation as foreseen in the magnificent visions of Nahum and Zephaniah, of Ezekiel and Isaiah. Such hideous wickedness could not be allowed to last. Their doom indeed was written in the moral law; and one of these prophets expressly founds his predictions on his confidence in that law as the will of the "just Lord." "Every morning doth He bring his judgment to light; he faileth not."# But when the chariots of Assyria were still issuing from the gates of Nineveh—"the bloody city"—it required a prophet's eye to read the sentence. When Nebuchadnezzar, or his latest successor, was still lounging in his palace richly colored and shining with enameled walls—when the hanging gardens of Babylon were still in bloom—it required some open vision to foresee the time when they should exist no more—when for centuries the very site of them should be uncertain—and when the mounds of their ruin should be given over to the owls and to the bats.

Then there is a higher sphere of prophecy into which we rise

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* In connection with the Palestine Exploration Fund. † Deuteronomy, i, 28.

‡ Assyrian Discoveries, by George Smith, pp. 256–282, and *passim*.

\# Zephaniah, iii, 5.

upon steps more solid even than the buried slabs of Nineveh. There are some splendid and powerful words in one of the books of the New Testament which indicate the true value to be set upon the demonstrable facts of Hebrew prophecy—first, as a support to our faltering, or to our faint, beliefs, and then as a guide to still deeper spiritual insight. I speak of the call which bids us "take heed" to "the more sure word of prophecy, as unto a light that shineth in a dark place, until the day dawn, and the day star arise in our hearts."* They point especially to those Messianic visions in which some Jews, speaking to other Jews, yet burst through all the barriers of their intense exclusiveness, and tell them to look to a Deliverer in whom the Gentiles were to trust, and who was to be the Desire of all nations. Other men than those who claim exclusively the name of critic must really be allowed to have some inner consciousness of their own—some power to recognize voices which are full to overflow of intimations from the spiritual world. It is impossible for any open-minded man to follow those lofty strains without recognizing the mystery and the majesty of their import. It is no more possible, when doing so, to listen to the carpings of the verbal critics than it would be to listen to the rasping noises of some petty mechanical operation when the thunders of heaven are pealing overhead.

And here I may be permitted to express a very strong opinion that in recent years Christian writers have been far too shy and timid in defending one of the oldest and strongest outworks of Christian theology. I mean the element of true prediction in Hebrew prophecy. It may be true that in a former generation too exclusive attention had been paid to it, and too much stress had been laid upon details. Nay, more, it may be true that the attempted application of prophecy to time still future has been the cause of great delusions amounting almost to religious mania. But the reaction has been excessive and irrational. A great mass of connected facts, and of continuous evidence, remains—which can not be gainsaid. Even if the greater prophets could be brought down to the very latest date which the very latest fancies can assign to them, they depict and predict overthrows and vast revolutions in the East which did not take place for centuries. It is easy to see how and why this reaction has arisen. Besides that mere swing of the pendulum which affects more or less all progress in human thought, a false analysis of physical science has intimidated men into a languid submission to that greatest of all fallacies which is embodied in the very word "supernatural." They tell us they can not believe in what they call the supernatural. But neither need they do so. For my own

* 2 Peter, i, 19.

part, I believe in nothing "above" nature or outside of it, which is not also in it, and visibly shining through it. It is so particularly with predictive prophecy. There is nothing more thoroughly in harmony with the system of things in which we live. The conception that all future events are connected with the present by the links of natural consequence, is a conception familiar to all science and to all philosophy. That those links should be capable of being followed, and their results foreseen by adjusted eyes, is quite according to the natural constitution and course of things. Prophetic prediction is implicit—to an almost miraculous degree—in the mysterious instincts of many of the lowest animals. It is explicit, more or less, in all the intuitions of human genius; and there is nothing difficult to conceive in this faculty being strengthened, intensified, and glorified, in minds whose relations with the spiritual world are close and special. In a more literal sense we may say of the Hebrew prophet what Tennyson says of the ideal poet:

> "The marvel of the everlasting will,
> An open scroll,
> Before him lay."

It is a comfort to observe that Prof. Huxley is not very sanguine as to the early triumph of his own nonsense. There is no ground, he says, "for much hope that the proportion of those who cast aside these fictions and adopt the consequence of that repudiation, are, for some generations, likely to constitute a majority." Certainly not. Prof. Huxley must know that the ranks of science are crowded with men, quite as eminent as himself, who are believers in Christianity. For more than "some generations" these men are likely to have successors. A few Christian sects have lately been showing signs of a disposition to divorce belief from facts, and from all definite conceptions of objective truth. An authority among them has lately uttered a warning voice. He has told them that they have in consequence been losing ground. "The undogmatic churches have reaped the scantiest harvest, while the dogmatic churches have hitherto taken the multitude."* This is bad hearing for Prof. Huxley. But it is good hearing for all who hold that morality itself can not be maintained except in connection with definite beliefs. The result, so disappointing to agnosticism, is the result of a great law—Nature abhors a vacuum. Men can not live on a diet of negations. Both our intellectual and our moral natures have digestive apparatuses of their own. They require their appropriate food, and Prof. Huxley has none to give them. The sect of the know-nothings is not likely to be ever popular, still less to overspread

* Address of the President of the Congregational Union at a late meeting.

the world. It is too barren, too empty-handed. It makes even science poor, robbing it of half of its intellectual interest and of almost all its charm. Men who talk about "plans," and "apparatuses," and "contrivances," and then tell us they don't mean what the words imply, are feeding themselves and us on husks indeed.

But Prof. Huxley has his revenge. In words which seem to express the most supercilious contempt, he refers to those who, "having distilled away every inconvenient matter of fact in Christian history, continue to pay divine honors to the residue." This is a bitter sentence. I do not think it is a just one as applied to the authors of the volume called Lux Mundi; but I fear it is more justly applicable to religionists of the Robert Elsmere type. Prof. Huxley ridicules them in a mock sentence supposed to be coming in some Bampton Lecture of the future: "No longer in contact with fact of any kind, faith stands now and forever proudly inaccessible to all the attacks of the infidel." I should not like to speak in this tone to, or of, any minds which are perplexed. But I agree with Prof. Huxley that, as flesh and blood must have a skeleton, so both sentiment and faith must have an object. They can not hang in air with no footing either in earth or heaven. Nothing can be more certain than that "nature" did not generate itself. The things which are seen were certainly not made of things that do appear.* The things which are seen are all temporal. It is the things which are not seen that are alone eternal. All this belongs to our universal experience, and is part of our all too scanty stock of necessary truths. What we call nature—ourselves included—must have had an origin and a cause. These are the objects of religion. Of two things we may be sure about theology: first, that there must be facts concerning it; and, secondly, that these facts must be the supreme facts with which we have to do. They may or may not be accessible to us, but they must exist as realities—with all their dynamic apparatus, and with all their corresponding laws. It is the business of all men to see those facts as best they may, and to obey those laws as best they can. It is impossible, therefore, to admire or even to respect the attitude of men who, in these matters, do nothing but stand by the highwaysides of life mocking. Least of all is this attitude to be respected in our professed agnostics. They should at least remember that they have nothing to give us of their own. Ignorance—even fictitious ignorance—is the motto on their flag. They do not plead it humbly as a confession, or use the sense of it as a stimulus to exertion. They claim it proudly as a boast, and use it as a weapon to repulse the light. With them knowl-

* Hebrews, xi, 3.

edge is "quite shut out," not because they have by nature no sense enabling them to see it, but because they choose to close its door and to starve it into atrophy. They are the men who can not rise to the higher interpretations even of their own science, or read the discoveries of their own dissecting knife. We accept their teaching as far as it goes, but we need not and can not accept their mastership. We desire to assimilate every fact which they can prove, and we are grateful for all the thought, and care, and labor, through which alone these facts have been established. But other men must be allowed to see other related facts to which experts may be blind. On any pure question of biology there is no man to whom we can go more safely than to Prof. Huxley. An original and careful investigator, a brilliant expositor, and in many things a cautious reasoner, he enjoys, on his own ground, a high and a just authority. But off that ground he passes into the shadows of a great eclipse. He labors under insuperable bias. Through this, and this alone, and through—we may be sure—no conscious unfaithfulness to truth, there is one great subject on which his judgment is warped by an obvious antipathy. On all questions bearing on "Christian theology" he is not to be trusted for a moment. Loud and confident in matters on which both he and we are profoundly ignorant, we see him hardly less boisterous in asserting ignorance where the materials of knowledge lie abundant to our hands. We have seen his canons of criticism—how rude and undiscerning; his claim for the physical sciences—how inflated; his own dealings with one of them—how shallow and how dogmatic. Prof. Huxley may depend upon it that the time has come when the great questions raised by the indisputable facts of Quaternary geology—of which the Deluge is perhaps the least important—must be taken out of the hands of men who, by his own confession, have hitherto dwelt with them in no voice more articulate than a smile, and in no attitude more intellectual than a shrug.—*Nineteenth Century.*

In a paper by Prof. Warren Upham, On the Cause of the Glacial Period, it is admitted, on the evidence afforded by a large number of recent independent discoveries and calculations, that the date of that period can not be set further back than about ten thousand years; the dates surmised by Croll and Geikie are therefore vastly exaggerated and impossible, and with them must fall the cosmical theory. Hence new causes must be sought. Prof. Upham looks for them in a higher elevation of the continent, which seems, however, to have been followed by a depression under the ice-sheet; a land barrier existing between Europe and Greenland, and shutting southern waters out from the Arctic Ocean; and a submergence of the Isthmus of Panama, turning the southern waters toward the Pacific Ocean.

MY GARDEN ON AN ONION.

By KATHARINE B. CLAYPOLE.

THERE was one great difference between this garden of mine and the gardens of my neighbors—an enormous difference, I might say—for, while they had onions *in* their gardens, my garden was *on* an onion. In fact, the onion was my garden, and in some respects this was an advantage to me. I had no soil to prepare, no seed to sow. I had merely to keep my onion a little moist, and the crops appeared of themselves.

The first to come was a sage-green down, appearing near the neck of the onion, just where the clear, shining scales close round the stalk. If the onion were put into the earth, this stalk would shoot straight up and bear a crown of flowers, followed by a crop of onion seed. It makes efforts to sprout even in a dark cellar. It pushes the scales apart, and the last remnant of life leaves them—of their own life, I mean, for, no sooner are they dead, than a host of tiny spores find life-food in their remains. These spores had been falling on my onion scales for months, but, so long as the scales were unbroken, could gain no roothold. Now thousands of them had pushed out little threads, which, branching and interlacing with each other, at last formed a film that the eye could see. Then quickly followed the sage-colored, velvety spots, and I knew that my first crop was ready for examination.

What was it?

The housekeeper called it mold. She said that my onion "had begun to get moldy." Mold is one of her deadly enemies. She recognizes it as a sign of rot or decay, and, wisely from her point of view, she gets rid of it as quickly as possible. I called it mold also—a mold. For I knew that before long there would appear other crops unlike this one, yet like enough to bear the name of mold also. I knew, too, that though these molds are almost too small to be seen by the naked eye, they have cousins that every one knows by sight. There are the mushrooms, the toadstools—yellow, red, and brown—the gigantic puff-balls, and many an odd-looking mass simply called "a fungus." The term fungus, or more often its plural form fungi, denotes a most persistent, industrious class of plants whose one aim in life is the production of millions and millions of spores. The sage-green spots on the neck of my onion were the spores of a fungus. With a needle I could scatter them like a cloud of fine powder. But I could not see how they were growing on the little plants without a microscope that would magnify them about three hundred times.

With such a microscope I saw transparent, branching, interlacing threads, called *hyphæ*, and thousands of loose spores. Many of the threads ended in little tassels. These tassels I found to be formed in a very interesting manner. First, the creeping *hyphæ* send branches into the air. Then these branches bear each three or four branchlets. From the ends of the branchlets grow a number of fine, parallel threads called *sterigmata*. The ends of these *sterigmata* contract and form little round, bead-like bodies commonly known as spores. As they are, however, actual bits of the branching *hyphæ* —bits exactly like the rest of the *hyphæ* in their constitution—they have no right to be called spores. The name *conidia* has, therefore, been made for them, from a Greek word meaning dust. As soon as each of these *conidia* or dust-like bodies is completed, another forms behind it, a third behind the second, and so on; the first being thrust forward until at last it is pushed off altogether and falls. The second shortly follows it, and then the third, and so the process goes on, old *conidia* falling off at one end and new ones forming at the other. It is these strings of *conidia* that give the tassel-like look to the ends of the aërial *hyphæ*. To the botanists who first studied them they suggested little brushes; the brushes that artists call pencils—camel's-hair pencils, for instance. The Latin name for brush being *penicillum*, this "brush"-bearing fungus received the name of *Penicillium*. Moreover, to distinguish a *Penicillium* with sage-green brushes, a second name, *glaucum*, was found. The first crop to appear on my onion was, thus, *Penicillium glaucum*, a fungus by no means confined to onions. My housekeeper has taken felted masses of it out of her cans of fruit; has bewailed its sage-green *conidia* on her jam, and even on her bread and pies. Indeed, she has to keep a sharp lookout for them, never knowing where they may next appear. I can only tell her that the air is full of them, and that they settle here, there, and everywhere, and will surely grow wherever they find moisture and nourishment to suit them.

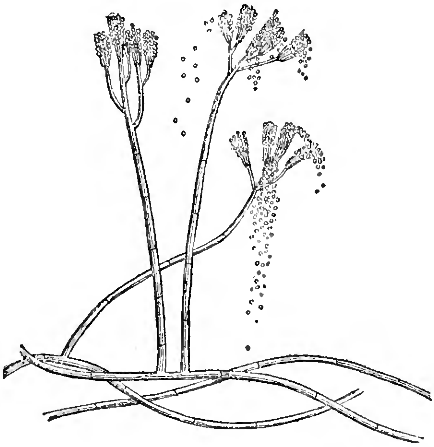

Fig. 1.—Penicillium glaucum.

The next crop that my onion bore made grayish patches on the outermost of those juicy layers, the bases of last year's leaves. With the eye alone I could make out the separate little plants, and, when I held a magnifying glass over them, it was like looking down on a fairy forest of brown-stemmed, branching trees covered with a luxuriant, silvery foliage. In this miniature tree I recognized a mold called *Polyactis* (many-branched), a fungus that is sure to show itself, sooner or later, on decaying vegetables. To remove one of the little trees and place it under the microscope required as much patient care as I could muster; for not only does the *Polyactis* take a firm hold of the leaf-base with its spreading, root-like *hyphæ*, but at the least jar it sheds its foliage, branches and all, and nothing remains but an uninteresting, pointed stem. Yet, if we could continuously watch this stem for a day or so, it would prove anything but uninteresting. Almost at once the protoplasm stored within it begins to form other branches as luxuriant as those that fell. When each is furnished with a due amount, a partition cuts it off from the main supply. Henceforth it rests merely upon the parent stem. It sends out branches on its own account, and gradually gives over its protoplasm to them. These branches fork and fork again, until at last the protoplasm is all concentrated in the ends of tiny branchlets, which swell and sprout all over with little points or *sterigmata*. Each little point contracts and then swells at the end to form an oval, bladder-like body. It is these oval bodies that give the look of foliage to the *Polyactis*, and as soon as they have received the whole nourishment of the branchlets they cut themselves off from their *sterigmata* and hang together in a grape-like cluster. These are the *conidia* that it has been the business of the whole plant to produce, and, in order that more may be borne by the same stem, they must speedily fall and carry the empty branches with them.

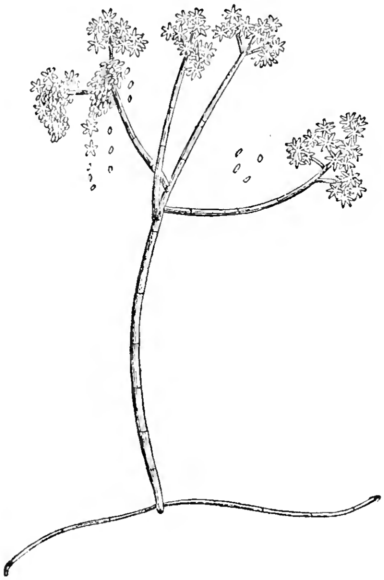

Fig. 2.—Polyactis cinerea.

The third crop appeared where I least expected to see it—on the heads of my *Polyactis*. First of all, fine, silvery lines ran from one *Polyactis* tree to another, looking, through the magnifying glass, like part of some complicated system of telegraph wires. In a day or two they formed a perfect network, on which pink dots began to appear. The dots increased in number, and soon the *Polyactis* was completely covered with a pinkish film. The film was pretty in itself, and I was forced to admire it, although I regretted the untimely extinction of my *Polyactis*. Shortly, however, it turned a dingy brown and fell to the onion, crushing the *Polyactis* under it. The *conidia* of the *Polyactis* germinated, and sent up another crop of tiny trees; but they had not run their little cycle of changes long, before the fine white lines appeared among them. The pinkish film followed, and then, again, film and *Polyactis* fell to the onion in a dirty-looking mass. The *Polyactis* took a fresh part of the leaf-base; the pink film followed it. *Polyactis* tried the inner side of the leaf-base; the film found it even there. The *Polyactis* crept up the sprouts that had burst through the scales; the film still pursued it—in fact, the *Polyactis* could grow nowhere on this onion without being overrun by the silvery threads. For days I watched the strife with naked eye, magnifying glass, and microscope, and saw the *Polyactis* gradually succumb and the onion itself rot and blacken under the repeated attacks of the pink-dotted film.

The microscope showed the film to be a tangle of fine, transparent *hyphæ*, and the pink dots little balls containing spores. Very beautiful are these *Baryeidamia* spore-balls, changing, as they mature, from pink to a rich seal brown, and surrounded always with clear, scalloped edges. In such profusion, also, are they produced that hundreds of them may be taken up at once on the point of a needle.

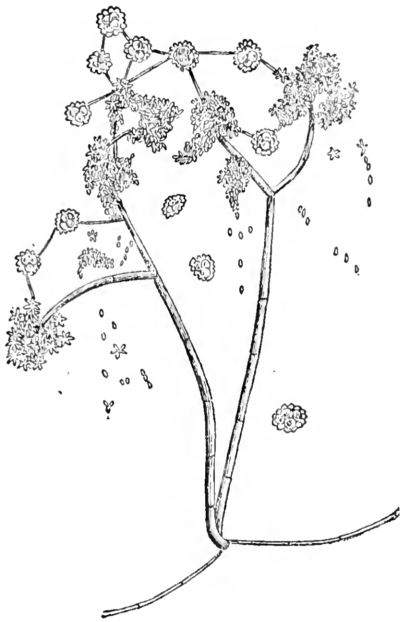

Fig. 3.—Polyactis overrun by Baryeidamia parasitica.

Though the most successful, these were by no means all the crops that my onion bore; at least three other minute fungi struggled for existence, but could gain no headway against the pink-filmed *Baryeidamia*. These, like the *Penicillium*, *Polyactis*, and *Baryeidamia* itself, were all of a comparatively harmless kind. They were merely scavengers, seeking their living on parts of the onion already dead, and thriving on material that it no longer had power to use. The onion, however, had nourished at least one fungus of a very different nature. My microscope showed me its clear, crescent-shaped *conidia*, and in the tissues of the leaf-bases its *hyphæ* were creeping from cell to cell, stealing the nourishment prepared for next year's sprouts. This fungus is a thief preying on the industry of the onion—it is more than a thief, for its ravages leave destruction and death in their wake.

The warmth and moisture necessary for the growth of my crops were not good for the onion. It developed untimely, sickly sprouts from the interior layers, while the exterior became the prey of swarms of those minute forms of life known as *bacteria*—forms that lie, as it were, in the border-land between plant life and animal, and whose function it is to resolve complicated organic structures into their original elements. Under this process my onion sank into a mass of putrescence so ill-looking and ill-smelling that, ere its original elements were reached, I committed it to the swifter dissolution of the flames.

EVOLUTION OF PATENT MEDICINE.

By LEE J. VANCE.

"THIS wonderful remedy works like a charm"—so reads a bold advertisement now lying before me. Why should any patent medicine work like a "charm"? The modern notion of a medical remedy working like a "charm" is a survival of the belief that certain secret remedies are charms. This is the savage's view of all medicines. He mixes his medicines with magic. His remedies are magical remedies, his songs of healing are incantations, his prayers for restoration to health are magic formula, his doctors are magicians.

Patent medicine had its origin in folk medicine. We are thus enabled to examine patent medicine as a magical practice and art of gradual development and of slow and subtle transformation. We shall argue that the blind, unthinking faith in a secret compound known as "patent medicine" is, for the most part, a survival. Further, we shall be able to show how magical practices, as of the Indians, develop into the remedies of the folk, of the people who share least in progress; how folk practices, in turn, in the hands of the mediæval leech and alchemist, become "occult science"; how, finally, out of leechcraft and quackery was evolved our curious system of patent medicine. The modern doctor is the heir of the leech, apothecary, and alchemist. He too seeks the elixir of life. He now makes a lymph more wonderful than the witches' ointment, which enabled people to sail through the air.

Briefly stated, patent medicines are drugs compounded of unknown ingredients, and are intended for the relief or cure of the various ills that flesh is heir to. They always have been, and still are, prepared and put up in an entirely different way from all other medical compounds. In one sense, the word "patent" means plain or unconcealed, but that is the reverse of the meaning of the medicine in question. Time was when the state, for purpose of revenue, allowed the venders of medical mixtures to take advantage of the patent law. By an act of Parliament a duty was levied on bottles or packages containing prepared drugs, and a stamp showed that the tax had been paid. This regulation was early adopted by the United States, but a few years ago the law was wiped off our statute-books, and, to-day, no tax or license is necessary.

Now, in all patent medicines, whether ancient or modern, there are two elements—the element which we now regard as *magical* and that which we regard as *mysterious*.

The notions entertained of medicines and medicine-men by people in a low stage of culture are pretty much alike in different parts of the world. Everywhere savages attribute disease to evil spirits, revengeful enemies, and to various occult influences. Naturally enough, priests among rude people are doctors, and doctors are priests. The medicine-man is priest-doctor. Mr. Mooney, who has made a thorough study of the theory and practice of Cherokee medicine, observes that "every doctor is a priest, every application is accompanied by a prayer and a sacred song." He found that plants were selected on account of "some connection between their appearance and the symptoms of the disease."*

Here we meet with the magical element in medicine; for it is one of the recognized principles of magic that things like each other, in color or form, influence each other in a mystic way. On this belief in a real and material connection between an object and its image, or between things like each other, is based one half of the magic of ancient and mediæval times. Thus, the Cherokee doctor invariably prescribes a yellowish decoction for biliousness. Believing that heart troubles are caused by the lungs becoming wrapped up about the heart and impeding its action, the patient is treated with a preparation of fern leaves, because these leaves when young are coiled up, but unwrap as they grow older. Again, the medicine-man not only works on analogy or resemblance, but his remedies are put up in a mysterious way. The patient must not know the kind of stuff he is swallowing. According to Dr. Archie Stockwell,† the Indian doctor thinks that "a remedy to be of any value should be secret." To the same effect is the testimony of another expert.‡ "To keep their medicine from the gaze of the profane, a medicine-bag is prepared

* Journal of American Folk Lore, vol. iii, p. 42.

† Popular Science Monthly, September, 1886.

‡ Smithsonian Reports, 1886, Part I, p. 246.

from the skin of birds or small animals"—so writes Mr. Paul Beckwith.

Once more, certain plants and roots are endowed with magical virtues, chiefly in the way of charms. Like the Homeric Greeks, semi-cultured people believe that "certain roots ward off the evil influences of spirits." Mr. Theall well puts it, when he says that "charms and medicines are classed together by the Kaffirs." Among the ancients the art of medicine was little more than a trade in charms, philters, and amulets. In his history of folk medicine, Mr. Black mentions many of these curious remedies. Let it, therefore, be enough to say that all folk nostrums are believed to work like charms; otherwise they would not be prescribed.

The patent-medicine man can put anything he likes in his preparation, because his patients have unquestioning faith in nostrums mysteriously compounded. Thus, when the Chinese physician is out of drugs, he writes the prescription on a piece of paper, rolls it into pills, and the sick man swallows it. The whole theory of early patent medicine is based on analogy or on the association of ideas: for example, it makes no difference whether you swallow the name of the remedy or whether you take the remedy itself.

This theory was fully worked out in the mind cures and faith cures of the middle ages. Study the origin and history of plant names. Scan the list, and what do you find?

Some plants have animal prefixes, as dog-elder, dog-rose, cat's-tail, cow-bane, etc. Other plants derive their names from religious sources. Thus they are associated with the Virgin Mary, Saint John the Baptist, Saint James. Likewise, the Latter-day Saints have particular plants dedicated to their memory. Most of the plants with mystic names were supposed to have magical virtues, and so they were largely used in folk medicine. The weird associations clustering around many roots and herbs were enough to invest them with great repute. According to Mr. Dyer, "the plants which formed the witches' pharmacopœia were generally selected either from legendary associations or by reason of their poisonous and soporific qualities." In folk medicine, herbs are used not so much for their inherent medical properties as for their reputed magical virtues.

Another stage in the evolution of patent medicine is typified in the therapeutics of mediæval mystics and alchemists. The great plant in their pharmacopœia was the mandrake. Why? Simply because the roots of this plant were shaped like the human body. A preparation of mummy was also widely used. Why? On the magical reasoning that flesh thus embalmed would preserve the body impregnated with it. Then the alchemists believed that a solution of gold had great medicinal virtues. Why? On the theory that the strength and quality of the metal might be communicated to the body of the person taking it. Still more potent than the *aurum potabile* was the *elixir vitæ*, by which people preserved their youth and lived forever.

The magical element in patent medicine actually won scientific repute in the "doctrine of signatures"—a doctrine which held that plants and minerals, by their external character, indicated the particular disease for which Nature had intended them as remedies. Thus the *Euphrasia*, or eyebright, was good for the eyes; the wood-sorrel, being shaped like a heart, for the heart; the liverwort for the liver, and so on. Pettigrew, in his history of medical superstition, says that this fanciful and magical notion "led to serious errors in practice," and often to fatal results.

Observe that, at this stage of its evolution, patent medicine is herb medicine, and so it remained for a long time. The materials of the healing art were all vegetable. The patent-medicine man was a dealer in herbs, and his shop is well described by Romeo:

> "And in his needy shop a tortoise hung,
> An alligator stuffed, and other skins
> Of ill-shaped fishes; and about his shelves
> A beggarly account of empty boxes,
> Green earthen pots, bladders and musty seeds,
> Remnants of pack-thread and old cakes of roses,
> Were thinly scattered, to make up a show."

In those days the barber-surgeon and the apothecary were the recognized exponents of the healing art; to them patients repaired for treatment. "The students of medicine," Mr. Goadby, in his England of Shakespeare, says, "were usually extensive dealers in charms and philters." They were as ready "to sell love-philters to a maiden as narcotics to a friar." The Arabic physicians introduced chemical and mineral remedies into European pharmacopœias, and then patent medicines took a turn for the worse.

The mantle of alchemists and witches seems to have fallen upon certain "wise" men and women, whose medicinal preparations were invested with a dash of magic; so that their nostrums were held in popular favor. Lord Bacon complained of the weakness and credulity of men in his day. "They will," said he, "often prefer a mountebank or witch before a learned physician." Secret preparations were put up by physicians of repute. Thus, Sir Kenelm Digby made a sympathetic powder which was reputed to cure wounds. He even published a book of Choice and Experimented Receipts in Physick and Chirurgery. The efforts of physicians were directed to the invention of nostrums and charms, not to the cause of the disease or to the action of their remedies. Throughout the seventeenth and eighteenth centuries the manufacture of "secret" preparations increased enormously, and "choice receipts" were sold for large sums. Thus, the English Government paid one thousand pounds to one Johanna Stevens for her mysterious specific for the stone, which turned out to be calcined snail-shells.

Indeed, the sale of nostrums in England had now grown to be a most flourishing and profitable business. To such proportion did the trade grow that at last the Crown stepped in and demanded a duty and a restriction upon prepared drugs.

The two statutes which originated and regulated the right of compounding preparations of medicines were passed in 1783. The first act granted to his Majesty "a stamp duty upon all licenses to be taken by certain persons uttering and vending medicines, and certain stamp duties on all medicines sold under such licenses, or under authority of his Majesty's letters patent, except such as had served a regular apprenticeship to any surgeon or apothecary as chemist and druggist."

Two years later, by act, 25 George III, chap. 22, other and more liberal conditions and privileges were granted, as follows: "Any person whatsoever who has, or claims to have, any secret art or sole right of compounding preparations of drugs, and advertising and recommending the same as specifics for the cure or relief of any complaint or malady, shall affix a Government stamp to the vials, vessels, or inclosures containing them."

Any one who violated the statute or who defrauded the state of the stamp duty was adjudged a felon. In the strong words of the statute, such a person "shall suffer death, as in case of felony, without benefit of clergy."

These statutes remained on the books, with little alteration or amendment, for nearly a hundred years. In 1868 the Pharmacy act was passed "to regulate the sale of poisons for the safety of the public." But section sixteen expressly says that "nothing heretofore contained shall extend to or interfere with the making or dealings in patent medicines." In 1875 another act was passed to the effect that, "a uniform duty of five shillings be payable throughout Great Britain."

The general patent acts of the United States were passed in 1790. They follow, in many respects, the old English legislation on the subject. The sole right of compounding medicines was allowed under the phrase, "composition of matter." What may be patented? The law says, "any new and useful art, machine, manufacture, or composition of matter." See the result. To take a noteworthy example: a patent was denied to the discoverers of the anæsthetic powers of chloroform and ether, but quacks, with their nostrums, could take out patents. In 1874 a law was passed abrogating the practice of copyrighting labels for patent medicine or other articles of manufacture, and, instead, provided for registering such labels in the Patent Office. Several States still have "trade-mark laws," by means of which the name of a popular patent medicine is secured against imitation.

In our own day, the patent-medicine business has developed into alarming proportions. There never was a time when so many people put faith in patent compounds. There never was a time when so many nostrums with mysterious ingredients have been sold. And, lastly, there never was a time when nostrums had so few claims in the healing art.

It is surprising that the American people still retain their faith in patent medicines. Rather than pay an educated physician a fee of two dollars, some people will spend that amount for a bottle or a box of patent medicine. They will try one nostrum after another until they are cured or killed. The superstition is not confined to the common folk alone. People who should know better are among the best customers of the nostrum-vender. The steady purchasers of patent medicines are the poor and ignorant. To be ignorant is to be credulous, and it is to the credulity of our people that the nostrum-vender appeals so strongly. The farmers and their families are afraid of the doctor, but they make riends with the quack. A correspondent of the New York Sun, in describing the peculiarities of Western farmers,* says: "If one patent medicine fails, it is because it is not the right patent medicine, and they try another. They prefer patent medicine, partly because there is a certain mystery about the ingredients, and they are put up in an attractive form."

It is not easy to calculate how many millions of dollars are spent by Americans on patent medicine every year. Think of the enormous expense required to keep a preparation before the public eye—calendars, almanacs, cook-books, cards, high-priced articles in all the daily papers. Of course, the money to pay for this comes from only one source—from people who buy the stuff. The sale of a certain "vegetable" compound is said to have amounted in one year to three million dollars, and one third of that went the next year in advertising. Now, to yield three millions at least six million bottles must have been sold. That gives one some idea of the number of people who use such preparations.

It would appear, then, from the lavish manner in which our people pour out their hard-earned money, that they like to be humbugged, so the veteran Barnum once bluntly remarked. If they want to spend their cash for patent medicine, is not that their own business? Yes; but should not the law step in and save the poor and ignorant from their own folly? No; that very

* Aug. 24, 1890.

question came up in a patent-medicine case in New York State.* The judge tersely summed up the whole matter thus: "As to the public, if these pills are an innocent humbug, by which both parties" (the litigants) "are trying to make money, I doubt whether it is my duty on that question of property, of right and wrong between them to step outside of the case and abridge the innocent individual liberty, which all persons must be presumed to have in common, of suffering themselves to be humbugged."

But the trouble is, that too many patent pills and medicines are not "innocent" humbugs. On the contrary, a large class of patent preparations are deadly poisons. We do not call medicine in which chlorodyne, calomel, or opium is an ingredient, "innocent." We need only point out that most soothing-sirups contain opium; that most face preparations have arsenic and oxide of zinc; that most "stomach bitters," so called, are composed of powerful drugs or whiskey, principally; that most of the health-restorers contain narcotics.

The unrestricted sale of secret or quack medicines is objectionable. It has now become a matter of serious importance; it renders murder, suicide, and crime easy. People injured by taking patent medicine are not without a legal remedy. The Supreme Court of Georgia recently decided that nostrum-venders are liable for damages to any person who, relying upon their cleverly worded testimony, takes their baneful stuff.† To quote from the decision: "These proprietary or patent medicines are secret, or intended to be secret, as to their contents. They" (the venders) "expect to derive a profit from such secrecy. They are therefore liable for all injuries sustained by any one who takes their medicine in such quantities as may be prescribed by them. . . . He" (the victim) "has a right to rely upon the statement and recommendation of the proprietor, printed and published through the world."

It is time that some restrictions were thrown around the sale of patent medicines. Venders of secret remedies practice cruel and dangerous deception. The traffic in some sixty thousand nostrums, many of them containing deadly drugs, has given rise to an anomalous state of affairs. For obvious reasons, the law should compel nostrum-venders to make public the names and proportions of the ingredients. That is what is done in other countries. Even the Japanese are in advance of us in regulating the sale of patent medicine. They compel the proprietor of a secret remedy to present a sample, with the name and the amounts of the ingredients, directions for its use, and explanations of its supposed efficacy. Or, we might adopt the French plan of making

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* 18 Howard's Pract. Reports, 242.

† The Blood Balm Company *vs.* Cooper, decided October 14, 1889.

nostrum-venders declare the composition on a label and to submit the stuff to official analysis. In England, as in this country, the unrestricted sale of patent medicine has been again and again discussed in print, and the absence of proper legislation there has allowed quacks and impostors to grow and flourish.

Frankly speaking, nostrum-venders no longer rely on the curative power of their drugs. They depend now on the power of advertising almost exclusively. They have a literary man to "write up" the remedy in ingenious fashion; an artist to show the patient "before and after" using the panacea; a poet to compose odes and lyrics; a liar who rivals Munchausen; and a forger who signs all kinds of testimonials. The great point seems to be to make people feel that they are in the last stages of decline. A cleverly worded circular is enough to give one a fit of the blues. In the opening chapter of his amusing book, Three Men in a Boat, Mr. Jerome hits off this particular point. "I never read a patent-medicine advertisement," says one character, "without being impelled to the conclusion that I am suffering from the particular disease therein dealt with, in its most virulent form." It is not uncommon for the nostrum-vender to offer one thousand dollars reward for any case he fails to cure. He is safe enough, even if the remedy kills, for there is no time specified within which a cure is to be effected.

To this, then, patent medicine comes at last: "This wonderful remedy works like a charm," or else not at all.

THE FRENCH INSTITUTE.

By W. C. CAHALL, M. D.

THE Institute, as it exists to-day, is a creation of Napoleon, and, like all other organizations which arose under the First Consul, reveals his disposition for centralizing and supervising everything, even the literary and scientific societies. It is due to Napoleon, however, to say that he had a professional interest in these societies as well as a ruler's, for it must be remembered he was an engineer, and had a seat in the Academy of Sciences. While the Institute dates from Bonaparte, who modified the newly organized Institute of the Directory, the several académies of which it is composed are very much older. The Consul simply revived the academies in almost their original form, but placed them in a more intimate relation with the Government and with each other.

The Institute may be likened to a university, while the academies are as the colleges of a university, independent yet correlative. Just the contrary prevailed in England, for here the Royal Society was the mother society, and all the organizations for special study have been offsprings from her.

A century of honorable and useful works could not save the academies from the insatiable maw of the revolutionary Government, and on the 8th of August, 1793, the following article was proposed and passed: "Article I. All academies and literary societies patented and paid by the nation are suppressed."

When, two years later, the Directory restored and reconstituted the academies into the Institute, after the original plans of Colbert, the empty chairs of the old members told with what deadly thoroughness the Revolutionary Committee suppressed the learned bodies through the guillotine and exile.

There had been the *Académie Française*, *Académie des Inscriptions et Belles-Lettres*, *Académie des Sciences*, and *Académie de Peinture et Sculpture*, now styled *Académie des Beaux-Arts*. Under succeeding governments the Institute and its academies underwent various changes as to name and classification of sections, but as they exist to-day the several academies are fulfilling practically the same aims and functions with which they started. A fifth academy was added by Guizot in 1832, as *L'Académie des Sciences Morales et Politiques*.

I. The *Académie Française* is the oldest, and in many respects, the most illustrious of the five.

The great Cardinal Richelieu, betwixt his intrigues of state and his more laborious task of writing indifferent tragedies, found time to play the patron to a *coterie* of learned men, who met at regular intervals for social and intellectual intercourse. Whether through his political insight or literary ambition it is not possible to know, but he clearly foresaw what a powerful influence such a society might wield, and esteemed it good statecraft that the Government should hold a supervisory interest. All was grist that came to his mill. For several years, or as early as 1630, Godeau Gombauld, Giry Habert, Serisay de Malleville, Chapelaine, author of La Pucelle, and other literary men of note, had been accustomed to meeting weekly at the house of Conrart, secretary of Louis XIII, where literary subjects were the usual topics, and where new works of the members were read. Since even such harmless societies were contrary to the law of France, strict secrecy was enjoined. But Richelieu had ears all over France. In 1633 Malleville took with him to the meetings his friend Farey, who, in all innocence, introduced the Abbé Bois-Robert. This satellite of the prime minister proved to be the ears in this instance, and reported to his master the excellence of these gatherings. Richelieu lost no time in offering to act as patron to the society, extended to it his protection, and promised letters of incorporation. The members would have been quite content to have continued their meetings in their former quiet, informal way. At the same time the condescension of the august prelate was not to be gainsaid, for, while he could purr as gently as a cat, he could strike with equal swiftness when it suited his purpose. A prime minister, in those days, preserved his own head by cutting off the heads of others, and the gentle priest had become wonderfully expert at this business.

With commendable promptness the members meekly drew up a code of regulations. They were to have only forty members. The officers were to consist of a director, who should preside over their deliberations; a chancellor, who should act as keeper of seals; and a permanent secretary.

The title of "The French Academy" was adopted, and its object was avowed to be "to labor with all care and diligence to give certain rules to our language, and to render it pure, eloquent, and capable of treating the arts and the sciences. It shall be the object of the new academicians to purge out of it those impurities with which it has become polluted."

The cardinal passed the statutes, and the king signed the letters patent on the 2d of January, 1635. When the Chancellor of State, Peter Seguier, impressed the charter with his great seal, he expressed his wish to become a member.

So far all was smooth sailing; but the Parliament of Paris, whose assent was necessary before the Academy could become legally constituted, proved obdurate, and it was not until after two years and a half, with all the powerful influence of the king, and his more dreaded prime minister giving it urgency that the coveted act was passed, with the qualification, however, that the academicians should "bind themselves to take cognizance of no other matters than the embellishment and enriching the French language, and to sit in judgment upon no books save such as were written by their own members, or by authors who should willingly submit themselves to academic discipline."

As a balm for their wounded feelings, the Government decided that each member of the Academy should receive an annual pension of two thousand francs. It was a source of no little scandal when it became known that they were paid out of a fund of forty times two thousand francs, which had been appropriated to pay the scavengers of the streets of Paris. The members themselves did not escape a just popular censure for the complacent manner with which they allowed themselves to be used by the wily cardinal.

The condemnation of The Cid of Corneille, which Richelieu instigated Chapelaine to write and the Academy to pass, will always be remembered against them. Much has been made of this incident, and the rejection of Molière, Boileau, La Bruyère, and Pascal; but these were almost the only exceptions to the rule that the greatest names in French literature were among the "Forty Immortals." And, as a matter of fact, Corneille was later on elected to membership, as were also Boileau and La Bruyère. If Molière was rejected because he was an actor, is it not currently reported that Henry Irving in our day is denied a knighthood for a like reason? But even of this action the Academy has thought better, for Molière's bust, which has been placed in the *Salle des Séances*, bears these words, "Rien ne manque à sa gloire; il manquait à la notre."

There are no two opinions as to the influence of the Academy upon the French language. It can be said, almost without exaggeration, that the French language has made greater conquests than the French army, for surely it has subdued courts where the French soldier had been impotent. As to its efficiency as a vehicle for literature classified as *belles-lettres*, it is the language *par excellence*, and its influence upon the world's literature is still tremendous. In clearness of expression, in perfection of form, in all that is meant by style, the French language is perhaps second only to the ancient Greek.

What the schools and philosophers of Athens did toward the perfection of the Ionic dialect, the French Academy has done for the French. Could there be any higher term of encomium than this? Yet this is the heritage of the Academy—not of one individual or of one generation, but of the accretions of generations of men laboring toward one end.

II. *Académie des Inscriptions et Belles-Lettres.*
III. *Académie des Sciences.*
IV. *Académie des Beaux-Arts.*
V. *Académie des Sciences Morales et Politiques.*

From the halcyon days of *le Grande Monarque*, three of the academies—II, III, and IV—date their beginning.

L'Académie des Inscriptions et Belles-Lettres, originally appointed to prepare inscriptions and mottoes for medals for King Louis XIV, became a chartered body under Colbert in 1663, when its scope was widened by assuming as its province the discussion of archæology in its various bearings.

L'Académie des Beaux-Arts arose from the *Académie de Peinture*, founded by Le Brun in 1648, and enlarged and incorporated by Colbert in 1664, as the *Académie Royale de Peinture et Sculpture*; it busies itself with painting, sculpture, architecture, and music.

L'Académie des Sciences Morales et Politiques is the youngest of the five, dating only from 1832, and has for its especial investigation mental philosophy, jurisprudence, and political economy.

L'Académie des Sciences, like the Royal Society of England, had a pre-official existence. A company of scientific men were accustomed to meet weekly at the house of some of the members in order to discuss, in an informal way, the current scientific topics of the day. Colbert, with wise discernment, saw that it would be advantageous to give them official recognition. He induced Louis XIV to bestow upon the newly organized body extensive grants for pensions, experiments, and instruments. Under this provisional charter the Academy met for the first time on December 22, 1666, in the rooms of the Royal Library. From this time forward a regular account of the proceedings has been kept, and for the first time it was called *L'Académie des Sciences.*

Within the very year of Colbert's incorporating the Academy there was returned to Paris for interment the body of one who, more than any one else, gave life and direction to the Academy during its earlier and more informal years. Although having spent the greater part of his life in Holland, Descartes was a Frenchman, and lived for a while in Paris, where, in fact, many of his greatest physical investigations were begun. Descartes was a ferment. Already in England Bacon had cut himself loose from the Aristotelian philosophy of the school-men. Descartes followed with a similar upheaval upon the Continent. Yet the two philosophies were in no way akin, save in the interest their works aroused for the study of nature. In Bacon's shameless race for state honors his philosophical studies were but diversions; consequently his philosophy was vague and undefined. To Descartes, in his almost ascetic life, his philosophical studies became an all-absorbing passion; consequently his system of philosophy, if not clear in all its details, was pointed and forceful, and swept as if by storm over both the scientific and metaphysical worlds.

Colbert, pursuant of the policy of Louis XIV to make Paris the intellectual as well as the political center of Europe, invited Huygens to leave the Hague and take up his residence in Paris. This he did in 1666, France receiving from Holland this celebrated mathematician and astronomer in exchange for her loss of Descartes, who gave the best part of his life to that country. Huygens was not the only foreigner whom the honors and pensions of Louis XIV induced to leave their native land; Römer, a Danish astronomer, and the great Italian astronomer, Dominic Cassini, being among the most eminent. Since the astronomical labors of these three men were so interwoven and interdependent, they can be considered together.

The Observatory of Paris was established in 1667, eight years before the Observatory of Greenwich was built. The French monarch appointed Cassini as the first director of the National

Observatory, and it is a remarkable fact that for four successive generations, covering a period of one hundred and twenty-two years, a Cassini was the director of the Paris Observatory. Dominic Cassini gave so much promise that at the age of twenty-five he was appointed Professor of Astronomy at the University of Bologna, and his reputation had already become so great that when Louis XIV, through his ambassador, requested Pope Clement IX and the Senate of Bologna to permit him to go to Paris, they yielded only for the limited term of six years. But, once in Paris, Louis XIV knew how to keep him.

The young Academy of Sciences received a great impetus through the labors of such men as Römer, Huygens, Cassini, Picard, and Mariotte. Cassini completed the unfinished work of Huygens's observations, and Huygens could not have elaborated his doctrines of the undulatory theory of light had not Römer just previously proved the velocity of light.

It was universally believed and taught that light was instantaneous. Römer observed that the eclipses of the satellites of Jupiter were earlier or later than the calculated time according to the time of year. He discovered that the premature eclipses always occurred when the earth was in its orbit nearest to Jupiter, and the delayed eclipses when farthest away; that the difference in time was about eleven minutes, which he correctly assumed as the time it took light to traverse the orbit of the earth. The velocity of light was thus mathematically established and measured. This discovery of Römer was made use of by Huygens in his development of the undulatory theory of light.

Hooke had, indeed, in his Micrographia, suggested some such an explanation of light; but to Huygens justly belongs the great honor of giving his theory a scientific basis. He taught that light was propagated in waves spherically, after the manner of sound. The adherents of the emission theory of light argued that light only moved in straight lines, but not around a corner as sound does, and as light should do if it moved in like manner.

The point was well taken, and for a long while was the stumbling-block in the way of the undulatory theory. Huygens met this objection, and time has proved its correctness. He says light will not be diffused beyond the rectilinear space when it passes through an aperture, "for, although the *partial* waves produced by the particles compressed in the aperture do diffuse themselves beyond the rectilinear space, these waves do not *concur* anywhere except in front of the aperture."

The adaptation of the pendulum to clocks by Huygens was of inestimable value to astronomy by furnishing a standard measure of time. His method of grinding lenses so improved the defining power of telescopes that he was enabled to discover the true nature of the ring of Saturn, which Galileo, with his more imperfect instrument, failed to make out. He also discovered one of the satellites of Saturn, but refused to look for more, since there were now as many satellites discovered as there were planets, and, from a false conception of the harmony of the universe, he considered it useless to search after others. He had the mortification of witnessing the success of Cassini in discovering four others.

In January, 1699, a new charter was granted to the Academy of Sciences. Until this time its charter was only preparatory, no provision having been made for the government of the society, its purpose, or the election of new members. The new charter provided for twenty *pensionnaires*, three geometricians, three astronomers, three chemists, three anatomists, three botanists, three to study mechanics, one secretary, and one treasurer; twenty associates, of whom eight may be foreigners; twenty *élèves*, or pupils, who acted as assistants to the associates; and ten honorary members. At the beginning of the year each member must declare the object of his study for the coming year, and all experiments must be repeated and tested by the Academy as a body. The Academy could not fill the vacancies in its own membership, but must recommend two or three candidates for each vacancy, and the Government had the right to make the selections from those recommended. The king had rooms fitted up for the Academy in the Louvre, where the organized body met for the first time April 29, 1699.

Under the labors of the Cassini, Malebranche, Fontenelle, Tournefort, Maraldi, and Méry, the reputation of the Academy of Sciences continued to increase until the growing luster of Newton's investigations and those of other members of the Royal Society threw it somewhat into shadow. Unfortunately, a spirit of national jealousy caused the scientists at Paris and London to misunderstand or willfully underestimate the services of their rivals, which delayed the settlement of many scientific questions longer than was otherwise necessary.

It was said of Fontenelle, who was Secretary of the Academy of Sciences for forty-two consecutive years, that when his Géométrie de l'Infini was submitted to the Academy, he declared, "There, now, is a book which only eight men in Europe can understand, and the author is not one of the eight."

While the Cassinis were for so long time making their name famous at the Paris Observatory, there lived in Paris a family of Jussieus, five in number, and through a period of nearly a century and a half, whose labors in the *Jardin du Roi* and Academy of Sciences made them equally famous as botanists. With the Jussieus arose the "natural method" of botanical classification, as it is known, in contradistinction to the artificial of Linnæus.

Linnæus found botany a chaos and left it a rigid science; yet Linnæus acknowledged his system to be artificial. "Artificial classes," says he, "are a substitute for natural till natural are detected," thus anticipating the better method in a riper time; and by a curious coincidence in the very year of his death, 1778, Antoine Laurent de Jussieu began writing his Genera Plantarum, which contained the proposed classification.

The honor of the invention of the natural method belongs to Bernard de Jussieu, who made use of it in the arrangement of the garden of the Trianon in 1759, rather than to his nephew, Antoine, who elaborated, perfected, and published it. The classification of the Jussieus was more philosophical than that of Linnæus, and eventually superseded, but did not destroy it; it arose rather as a superstructure upon Linnæan foundations, and built along the lines which Linnæus had already marked out. The Genera Plantarum has been characterized by Cuvier as a work "which perhaps forms as important an epoch in the sciences of observation as the Chimie of Lavoisier does in the science of experiment."

Antoine Laurent de Jussieu's Genera was scarcely finished before Paris ran mad. It was the time of the Revolution. Happily for him that his profession as physician kept him busy in the hospitals and out of public life during these terrible days! The comparative obscurity of his life at this time allowed him to safely pass through the bloody ordeal which destroyed equally innocent and noble-minded men. There was no head which the guillotine cut off that could not have been better lost than that of Lavoisier.

Black, Cavendish, and Priestley, in England, and Scheele, in Sweden, had been making invaluable discoveries in chemistry, but chemistry was still in disorder. Lavoisier's mental equipment placed him at the fore-front of the scientific experimenters of his day, and there was no one so well qualified to perform his chosen work in chemistry as himself.

In 1778, in a memoir to the Academy of Sciences, Lavoisier questioned the existence of "phlogiston," and attributed to oxygen the acidifying principle. A second memoir, in 1784, on the analysis of water, confirmed his position. In conjunction with other French chemists, he substituted for the cumbersome chemical terms a nomenclature of such scientific accuracy that, with slight modifications, it continues to the present day. Its way thus prepared, his Traité élémentaire de Chimie, which contained his innovations and came out in 1789, proved a death-blow to the phlogiston doctrines, and prepared the way for modern chemistry. A chemist of such qualifications was very naturally called into requisition by the state. He increased the explosive quality of gunpowder, devised a system of weights and measures, and served for twenty-one years as one of the *fermiers-généraux*. When the Academy of Sciences was suppressed in 1793, Lavoisier wrote to Lakanal, President of the Committee on Public Instruction, that the members of the Academy had formed a private society to continue their labors, and asked permission to use the Academy rooms. But even this privilege was denied them.

On the 2d of May, 1794, a general indictment was made in the National Assembly against the *fermiers-généraux* for *conspiring* against the Government, on the ground that they caused an adulteration of tobacco by the addition of water. Absurd as this charge appears to us of saner days, these men, including as they did some of the noblest of France, were actually tried, May 6th, and condemned to death, the entire body of twenty-eight being guillotined on the 8th of May, 1794.

After two years and a half of suppression the academies were revived by an act of the Convention of October, 1795, under the title of the "Institute," principally through the influence of Carnot, grandfather of the present President of France, who was at that time President of the Directory, and of Lakanal and Daunou. Instead of academies the Institute was divided into three classes, the first class for *sciences physiques et mathématiques*, the second class for *sciences morales et politiques*, and the third class for *littérature et beaux-arts*. The whirlwind of the Revolution swept away Directories and set up others. Carnot was obliged to fly for safety into Germany.

The seat in the class of mechanics of the Institute made vacant by the flight of Carnot was filled in 1797 by the election of a young artillery officer, Napoleon Bonaparte, just returned from his Italian campaign covered with glory. The First Consul paid much favorable attention to the Institute, and it continues to this day very much as it left his hands in the new constitution which he gave it in 1806. He exhibited his admiration for the pure sciences, and his dislike to the speculative sciences, philosophy and ethics, by the expansion of the Convention's first class and the entire suppression of the second class, thus creating four classes: *Sciences physiques et mathématiques, la langue et la littérature françaises, histoire et littérature anciennes*, and *beaux-arts*. It was Louis XVIII who, in 1816, restored the old names of the academies to the four classes of Napoleon.

Napoleon was fond of the society of scientists, and rewarded with prizes and honors the most noteworthy of scientific discoveries. Although at war with "*perfide* Albion," as he was wont to call England, he drew the line at scientists, and pardoned English prisoners at the simple request of Joseph Priestley, after all other means had been exhausted, and acceded to the award of three thousand francs by the first class of the Institute to Davy for his celebrated memoir of 1806. It was Bonaparte who proposed to award a gold medal to Volta, after reading his memoir on galvanism; and later induced Volta, by emoluments and titles, to surrender his Italian professorship for a residence in Paris. When the memorable expedition to Egypt set sail, Bonaparte took with him many *savants* and Academicians. After the wager of battle had turned against the great soldier, and he was transported to the lonely St. Helena, he must have felt that the last tie to France had been severed when, in 1817, he felt forced to resign his chair in the Academy of Sciences.

Napoleon's battle of the Pyramids and conquest of Egypt added little to his fame; but his soldiers, in throwing up intrenchments near Rosetta, dug up a long-buried stone, in time to be esteemed more valuable than a dozen victorious battles. This stone, which took its name from the place of its discovery, became known as the Rosetta Stone. It was found to be of black basalt; about three feet seven inches in length and two feet six inches in width, and covered with strange-looking inscriptions. The stone finally found its way to the British Museum, where it still can be seen, and where for many years scholars studied it in vain before its incalculable archæological value was discovered. The inscription was found to be trilingual, the upper lines being in the hieroglyphic, the second in the demotic, and the third in the Greek language. The Greek was soon translated and found to contain a decree in honor of Ptolemy Epiphanes by the Egyptian priesthood, and erected nearly two hundred years B. C. The inscription being identical in the three languages, the Greek thus became the key by which the hieroglyphics of tombs and obelisks, which had so long baffled the ingenuity of acutest scholarship, were easily deciphered. "The learned walls with hieroglyphics graced" became an open book, whereon the world with wondering eyes beheld ancient Egypt speak and live.

In the interpretation of the Rosetta Stone, and through this the interpretation of the hieroglyphic inscriptions of Egypt, more than to any one else the credit is due to Champollion. This eminent Egyptologist was nine years old when the Rosetta Stone was unearthed by his countrymen, but at an early age entered upon his famous career. At seventeen he wrote a valuable paper upon the Coptic language, at nineteen he was elected Professor of History in the Lyceum of Grenoble, and when but twenty-one published his L'Egypte sous les Pharaons. In his studies upon the Rosetta Stone Champollion followed the false belief, then prevalent, in the ideographic nature of the hieroglyphs. Dr. Thomas Young, of London, who was employed in parallel studies of the same subject, made the very important discovery of the phonetic or alphabetic character of the hieroglyphs. The eager perception of Champollion caught the suggestion, and at once putting it to the test and amplifying it until he had completed an alphabet, found true what Young had only surmised. Since, according to the old adage, which rules the scientific world, that "he only discovers who first proves," Champollion shares with Young the honor of making one of the most important discoveries of this century.

July 19, 1830, is the date of the sitting of the Academy of Sciences when the rupture between Cuvier and Geoffroy de Saint-Hilaire took place. It was a battle of giants. Although Paris was in commotion—for it was in the midst of the Revolution of July—the Academy was filled with French scientists. These life-long friends had for some years a growing difference, which from its very nature was irreconcilable, upon the comparative merits of the synthetic and the analytical methods of studying nature, and which finally resulted in the tempestuous debate in the Academy. Geoffroy, as a synthesist, maintained that organic forms are built on one plan of construction, of the same elements, of the same number, and of the same relation between organs; while, on the other hand, changed conditions varied the size and use of organs, but not the plan, and that species have undergone modifications in the change of time. Cuvier, as an analyst, could see no evidence of variability in species, and held that every organ was specially created for the purpose for which it was used. The echoes of this combat are still resounding throughout the scientific world, but with more and more unequaled result.

Geoffroy was one of Napoleon's scientific staff in Egypt, and for his firm stand, at the surrender of Alexandria, in resisting the claims of the English general to the rich collection, was honored upon his return with decorations by the emperor, and an election to the Academy of Sciences. In 1795 Geoffroy was put in correspondence with a youth in Normandy, who was devoting himself to natural history, and was so impressed with the originality of the young man's manuscripts that he invited him to Paris with the rather enthusiastic, but, as it proved, prophetic words, "Venez jouer parmi nous le rôle de Linné, d'un autre législature de l'histoire naturelle."

Georges Cuvier, to whom these words were addressed, came to Paris, entered Geoffroy's household, and wrote with Geoffroy many joint papers. It is to the credit of both men that the life-long friendship, which was for a time broken by the debate of 1830, was renewed and continued to death.

The undoubted genius of Cuvier was early recognized; for when, in 1795, the Institute was reorganized, he was elected a member of the Section on Zoölogy. This confidence was well founded, for his work was truly epochal, and to this day the name of Cuvier stands pre-eminent in the zoölogical world. His method of classification in zoölogy was revolutionary, and is still the recognized authority; his researches in comparative anatomy may be said to be creative, for not until then was it a science, and his influence upon paleontology was not less notable. Both Geoffroy and Cuvier, like most Frenchmen, took great interest in public affairs, and both filled posts of high honor and responsibility in the state.

Goethe, whose allegiance to the synthetic doctrines of Geoffroy may have biased his judgment against its great antagonist, says: "Cuvier, the great naturalist, is admirable for his power of representation and his style. No one expounds a fact better than he, but he has scarcely any philosophy. He will bring up very well informed but few profound scholars." It must be confessed that events have proved the criticism of Goethe to be true, unless we make the single exception of Milne-Edwards.

It was in the year 1852 that Léon Foucault, the distinguished physicist, conducted some experiments in Paris to prove the rotation of the earth, which for their simplicity and beauty aroused the admiration and wonder of his *confrères*. He constructed an enormous pendulum by suspending a ball by a fine wire from the dome of the Pantheon, and set it in vibration in a northerly and southerly direction. A pendulum thus started will continue to swing in the same plane for hours. By carefully marking upon the pavement the plane of swing and comparing it with that made after the lapse of several hours, it was seen that the earth had turned under it at a definite rate. This beautiful demonstration, making visible to human eyes the actual revolution of the earth upon its axis, was many times repeated, once in our own Capitol at Washington.

In 1801, the accommodations of the Louvre being no longer esteemed sufficient, the Institute was given rooms in the *Palais des Quatre Nations*, where the several academies meet successively in different rooms. Each academy governs itself and awards its own prizes, but the library and museum are held in common, and the Institute has two prizes separate from those of the academies. Each academy meets weekly, and once yearly in public, and the grand *séance* of the whole five bodies meets annually on the 15th of August.

A writer—it is but fair to say that he is an Englishman—thus compares the French Institute and the Royal Society of England: "The members of the French Institute receive a yearly stipend; the Fellows of the Royal Society pay an annual sum for the support of their institution and the advancement of science. It would be repugnant to the feelings of Englishmen to submit to the regulations of the Institute, which require official addresses, and the names of candidates for admission into their body to be approved by the Government before the first are delivered or the second elected. The French *savants* are, it is true, ennobled and decorated by orders, which the wiser among them, in common with true philosophers of any country, regard with indifference."

THE MEXICAN MESSIAH.

By DOMINICK DALY.

THERE are few more puzzling characters to be found in the pages of history than Quetzatcoatl, the wandering stranger whom the early Mexicans adopted as the air-god of their mythology. That he was a real personage—that he was a white man from this side of the Atlantic, who lived and taught in Mexico centuries before Columbus was born—that what he taught was Christianity and Christian manners and morals—all these are plausible inferences from facts and circumstances so peculiar as to render other conclusion well-nigh impossible.

When, in 1519, Cortes and his companions landed in Mexico, they were astonished at being hailed as the realization of an ancient native tradition, which ran in this wise: Many centuries previously a white man had come across the Atlantic from the northeast, in a boat with "wings" (sails), like those of the Spanish vessels. He stayed several years in the country, and taught the Mexicans (Toltecs) a new and humane system of religion, instructed them in the principles of good government, and imparted to them a knowledge of many useful industrial arts. He loved peace, and had a horror of war. By his great wisdom and knowledge of divine things, his piety and his many personal and godlike virtues, he won the esteem and veneration of all the people, and exercised great control over them. His sojourn in Mexico was a kind of golden age. Peace, plenty, and happiness prevailed throughout the land. The Mexicans knew him as Quetzatcoatl, or the Green Serpent, the word "green" in their language being a term for a rare and precious thing. Through some malign influence Quetzatcoatl was obliged or induced to quit the country. On his way to the coast he stayed for a time at the city of Cholula, where, subsequently, a great pyramidical mound, surmounted by a temple, was erected in his honor. On the shores of the Gulf of Mexico he took leave of his followers, soothing their sorrow at his departure with the assurance that he would not forget them, and that he himself, or some one sent by him, would return at some future time to visit them. He had made for himself a vessel of serpents' skins, and in this strange contrivance he sailed away in a northeasterly direction for his own country, the Holy Island, or Tlapallan, beyond the great ocean.

Such, in outline, was the tradition which Cortes found prevalent in Mexico on his arrival there, and powerfully influencing every inhabitant of the country. The Spaniards found that their advent was hailed as the fulfillment of the promise of Quetzatcoatl to return. The natives saw that they were white men, and bearded, like him; they had come in sailing-vessels such as the one he had used across the sea; they had clearly come from the mysterious Tlapallan; they were undoubtedly Quetzatcoatl and his brethren come, in fulfillment of ancient prophecy, to restore the period of peace and prosperity which the country had experienced for a short time many hundreds of years before.

The Spaniards made no scruple of encouraging and confirming a belief so highly favorable to their designs, and it is conceded by their writers that this belief, to a large extent, accounts for the comparative ease and marvelous rapidity with which a mere handful of men made themselves masters of a great and civilized empire and subjugated a warlike population of millions. To the last the unfortunate emperor Montezuma held to the belief that the King of Spain was Quetzatcoatl and Cortes his lieutenant and emissary under a sort of divine commission.

The Mexicans had preserved a minute and apparently an accurate description of the personal appearance and habits of Quetzatcoatl. He was a white man, advanced in years and tall in stature. His forehead was broad; he had a large beard and black hair. He is described as dressing in a long garment, over which there was a mantle marked with crosses. He was chaste and austere, temperate and abstemious, fasting frequently, and sometimes inflicting severe penances on himself, even to the drawing of blood. This is a description which was preserved for centuries in the traditions of a people who had no intercourse with or knowledge of Europe, who had never seen a white man, and who were themselves dark-skinned, with but few scanty hairs on the chin to represent a beard.

It is, therefore, difficult to suppose that this curiously accurate portraiture of Quetzatcoatl as an early European ecclesiastic was a mere invention in all its parts. Nor is it easier to understand why the early Mexicans should have been at pains to invent a Messiah so different from themselves and with such peculiar attributes. Yet, in spite of destructive wars, revolutions, and invasions; in spite of the breaking up and dispersal of tribes and nations once settled in the vast region now passing under the name of Mexico, the tradition of Quetzatcoatl, and the account of his personal peculiarities, survived among the people to the days of the Spanish invasion.

But time and change must have done much in the course of centuries to confuse the teachings of Quetzatcoatl. Notwithstanding such mutation, enough remained of them to impress the Spaniards of the sixteenth century with the belief that he must have been an early Christian missionary, as well as a native of Europe. They found that many of the religious beliefs of the Mexicans bore an unaccountable resemblance to those of Christians.

The religion of the Mexicans, as the Spaniards found it, was in truth an amazing and most unnatural combination of what appeared to be Christian beliefs and Christian virtues and morality with the bloody rites and idolatrous practices of pagan barbarians. The mystery was soon explained to the Spaniards by the Mexicans themselves. The milder part of the Mexican religion was that which Quetzatcoatl had taught to the Toltecs, a people who had ruled in Mexico some centuries before the arrival of the Spaniards. The Aztecs were in possession of power when the Spaniards came, and it was they who had introduced that part of the Mexican religion which was in such strong contrast to the religion established by Quetzatcoatl. It appeared further that the Toltec rule in the land had ceased about the middle of the eleventh century. They were a people remarkably advanced in civilization and mental and moral development. They were well versed in the arts and sciences, and their astronomical knowledge was in many respects in advance of that of Europe. They established laws and regular government in Mexico during their stay in the country, but about the year A. D. 1050 they disappeared south by a voluntary migration, the cause of which remains a mystery.

It was not until the middle of the fourteenth century that the Aztecs acquired sufficiently settled habits to enable them to found states and cities, and by that time they seem to have adopted as much of what had been left of Toltec civilization and Toltec religion as they were capable of absorbing, without, however, abandoning their own ruder ideas and propensities. Hence the incongruous mixture of civilization and barbarism, mildness and ferocity, gentleness and cruelty, refinement and brutality presented by Mexican civilization and religion to the Spaniards when they entered the country two centuries later. "Aztec civilization was made up," as Prescott says, "of incongruities, apparently irreconcilable. It blended into one the marked peculiarities of different nations, not only of the same phase of civilization, but as far removed from each other as the extremes of barbarism and refinement."

The better—that is, the Toltec—side of this mixed belief included among its chief features a recognition of the existence of a Supreme God, vested with all the attributes of the Jehovah of the Jews. He was the creator and the ruler of the universe, and the fountain of all good. Subordinate to him were a number of minor deities, and opposed to him a father of all evil. There was a paradise for the abode of the just after death, and a place of darkness and torment for the wicked. There was an intermediate place. There had been a common mother of all men, always pictorially represented as in company with a serpent. Her name was Cioacoatl, or the serpent woman, and it was held that "by her sin came into the world." She had twin children, and in an Aztec picture preserved in the Vatican at Rome those children are represented as quarreling. The Mexicans believed in a universal deluge, from which only one family (that of Coxcox) escaped. Nevertheless, they spoke of a race of wicked giants, who had survived the flood and built a pyramid in order to reach the clouds; the gods frustrated their design by raining fire upon it. Tradition associated the great pyramid at Cholula with this event. The traditions of Cioacoatl, Coxcox, the giants, and the pyramid at Cholula are extremely like a confused acquaintance with biblical narratives.

The points of resemblance with real Christianity were too numerous and too peculiar to permit the supposition that the similarity was accidental and unreal. The only difficulty was to account for the possession of Christian knowledge by a people so remote and outlandish—or rather to trace the identity of Quetzatcoatl, the undoubted teacher of the Mexicans. Their choice lay between the devil and St. Thomas. However respectable the claims of the former, it is clear enough that St. Thomas was not Quetzatcoatl and had never been in Mexico. He was dragged in at all because the Spaniards long cherished the idea that America was a part of India, and St. Thomas was styled the Apostle of India on the authority of an ancient and pious but very doubtful tradition. The weakness of the case for St. Thomas secured a preference for the claims of the devil, and the consensus of Spanish opinion favored the idea that Quetzatcoatl was the devil himself, who, aroused by the losses which Christ had inflicted upon him in the Old World, had sought compensation in the New, and had beguiled the Mexicans into the acceptance of a blasphemous mockery of the religion of Christ more wicked and damnatory than the worst form of paganism.

Lord Kingsborough makes the suggestion that Quetzatcoatl was no other than Christ himself, and in support of this maintains that the phonetic rendering in the Mexican language of the two words "Jesus-Christ" would be as nearly as possible "Quetzat-Coatl." He does not mean to say that Christ was ever in Mexico; but his suggestion is that the Mexicans, having obtained an early knowledge of Christianity and become acquainted with the name and character of its divine founder, imagined in subsequent ages that Christ had actually been in Mexico, and so built up the tradition of Quetzatcoatl. But this theory does not get rid of—it makes essential—the presence of a missionary in Mexico, through whom the people were instructed in the truths of Christianity, and from whom they obtained a knowledge of Christ.

It is hard to understand what it was that Quetzatcoatl taught if it was not Christianity, and equally hard to conceive what he could have been if he were not a Christian missionary. A white man, with all the peculiarities of a European, teaches to a remote and isolated pagan people *something* the remnants of which centuries afterward are found to bear an extraordinary resemblance to Christianity. The teacher himself is depicted as a perfect and exalted type of a Christian missionary, though the Mexicans could have no model to guide them in their delineation of such a character. Long, earnestly, and successfully he preached the worship of the great unseen but all-present God, and taught the Mexicans to trust in an omnipotent and benevolent Father in heaven. He preached peace and good-will among men, and "he stopped his ears when war was spoken of." He taught and encouraged the cultivation of the earth and the arts and sciences of peace and civilization. The impression he made was, indeed, so profound that the memory of his virtues and good works survived through centuries of change and trouble, and made him acceptable as a god even to the rude, intruding barbarians, who only learned of him remotely and at second hand ages after the completion of his mission. Can he, then, be an imaginary person? Could the early Mexican pagans have evolved such a character from their own fancy or created it out of pagan materials? The thing seems incredible. It would indeed be curious if the Mexicans—never having seen a white man, and wholly ignorant of European ideas and beliefs—had invented a fable of a white man sojourning among them; it would be still more curious if, in addition to this, they had invented another fable of that white man instructing them in European religion and morals. The white man without the teaching might be a possible but still a doubtful story; the teaching without a white man would be difficult to believe; but the white man and the teaching together make up a complete and consistent whole almost precluding the possibility of invention.

Three points in relation to Quetzatcoatl seem well established: (1) he was a white man from across the Atlantic; (2) he taught religion to the Mexicans; (3) the religion he taught retained to after-ages many strong and striking resemblances to Christianity. The conclusion seems unavoidable that Quetzatcoatl was a Christian missionary from Europe, who taught Christianity to the Mexicans, or Toltecs.

Accepting this as established, the possibility of fixing the European identity of Quetzatcoatl presents itself as a curious but obviously difficult question. To begin with, the era of Quetzatcoatl is not known with any precision. It has a possible range of some six and a half centuries—from before the beginning of the fourth century to the middle of the tenth century; that is, from about A. D. 400 to A. D. 1050, which is the longest time assigned to Toltec domination in Mexico. The era of Quetzatcoatl may, however, be safely confined to narrower limits. The Toltecs must have been well settled in the country before Quetzatcoatl appeared among them, and he must have left them some considerable time before their migration from Mexico. The references to Quetzatcoatl's visits to the Toltec cities prove the former, and the time which would have been required to arrange for and complete the great pyramid built at Cholula in honor of the departed Quetzatcoatl proves the latter. From a century to two centuries may be allowed at each end of the period from A. D. 400 to A. D. 1050, and it may be assumed with some degree of probability that Quetzatcoatl's visit to Mexico took place some time between (say) A. D. 500 and A. D. 900.

If attention is directed to the condition of Europe during that time, it will be found that the period from about A. D. 500 to A. D. 800 was one of great missionary activity. Before the former date the Church was doing little more than feeling its way and developing its strength in the basin of the Mediterranean, and making extensions in settled states. After the latter date the incursions and devastations of the northern barbarians paralyzed European missionary efforts. But from the beginning of the fifth to the beginning of the eighth century there was no limit to missionary enterprise, and, if ever a Christian missionary had appeared in Mexico, all the probabilities favor the theory that he must have gone there within those centuries. The era of Quetzatcoatl may therefore be narrowed to those three hundred years, and the task of tracing his identity thus simplified to some slight extent.

It may now be asked, Is it reasonable to expect that there are, or ever were, any European records of the period from A. D. 500 to A. D. 800 referring to any missionary who might have been Quetzatcoatl? It is a long time since Quetzatcoatl, whoever he was, sailed from the shores of Europe to carry the truths of Christianity into the unknown regions beyond the Atlantic, but the literary records of his assumed period are numerous and minute, and might possibly have embraced some notice of his undertaking. It seems unlikely that his enterprise would have escaped attention altogether, especially from the ecclesiastical chroniclers, who were not given to ignoring the good works of their fellow-religionists. Moreover, the mission of Quetzatcoatl was not one which could have been launched quietly or obscurely, nor was there any reason why it should be. The contemplated voyage must have been a matter of public knowledge and comment in some locality; it could not have been attempted without preparations on some scale of magnitude; and such preparations for such a purpose must have attracted at least local attention and excited local interest. It is thus reasonable to suppose that the importance and singularity of a project to cross the Atlantic for missionary purposes would have insured some record being made of the enterprise. *A fortiori*, if the venturesome missionary ever succeeded in returning—if he ever came back to tell of his wonderful adventures—the fact would have been chronicled by his religious *confrères* and made the most of then and for the benefit of future ages. It comes, therefore, to this—accepting Quetzatcoatl as a Christian missionary from Europe, we have right and reason to expect that his singular and pious expedition would have been put upon record somewhere.

The next step in the inquiry is to search for the most likely part of Europe to have been the scene of the going forth and possible return of this missionary. The island of Tlapallan, according to the Mexican tradition, was the home whence he came and whither he sought to return. The name of the country affords no assistance, and it might not be safe to attach importance to its insular designation. But in looking for a country in western Europe--possibly an island—which from A. D. 500 to A. D. 800 *might* have sent out a missionary on a wild transatlantic expedition, one is soon struck with the possibility of Ireland being such a country. To the question, "Could Ireland have been the Tlapallan, or Holy Island, of the Mexican tradition?" an affirmative answer may readily be given, especially by any one who knows even a little of the ecclesiastical history of the country from A. D. 500 to A. D. 800. In that period no country was more forward in missionary enterprise. The Irish ecclesiastics shrunk from no adventures by land or sea, however desperate and dangerous, when the eternal salvation of heathen peoples was in question. On land they penetrated to all parts of the Continent, preaching the gospel of Christ and founding churches and religious establishments. On sea they made voyages for like purposes to the remotest known lands of the northern and western seas. They went as missionaries to all parts of the coast of northern Britain, and visited the Hebrides, the Orkneys, and the Shetland and Faro Islands. Even remote Iceland received their pious attention, and Christianity was established by them in that island long before it was taken possession of by the Norwegians in the eighth century.

Prima facie, then, Ireland has not only a good claim, but really the best claim, to be the Tlapallan of the Mexicans. It is the most western part of Europe; it is insular, and in the earlier centuries of the Christian era was known as the "Holy Island"; between A. D. 500 and A. D. 800 it was the most active center of missionary enterprise in Europe, and its missionaries were conspicuous above all others for their daring maritime adventures. It is natural, therefore, to suspect that Ireland may have been the home of Quetzatcoatl, and, if that were so, to expect that early Irish records would contain some references to him and his extraordinary voyage. Upon this the inquiry suggests itself, Do the early Irish chronicles, which are voluminous and minute, contain anything relating to a missionary voyage across the Atlantic at all corresponding to that which Quetzatcoatl must have taken from some part of western Europe?

To one who, step by step, had arrived at this stage of the present inquiry, it was not a little startling to come across an obscure and almost forgotten record, which is, in all its main features, in most striking conformity with the Mexican legend of Quetzatcoatl. This is the curious account of the transatlantic voyage of a certain Irish ecclesiastic named St. Brendan, in the middle of the sixth century—about A. D. 550. The narrative appears to have attracted little or no attention in modern times, but it was widely diffused during the middle ages. In the Bibliothèque at Paris there are said to be no fewer than eleven MSS. of the original Latin narrative, the dates of which range from the eleventh to the fourteenth centuries. It is also stated that versions of it in old French and Romance exist in most of the public libraries of France; and in many other parts of Europe there are copies of it in Irish, Dutch, German, Italian, Spanish, and Portuguese. It is reproduced in Usher's Antiquities, and is to be found in the Cottonian collection of MSS.

This curious account of St. Brendan's voyage may be altogether a romance, as it has long been held to be; but the remarkable thing about it is the singularity of its general concurrence with the Mexican tradition of Quetzatcoatl.

St. Brendan, called the "Navigator" from his many voyages, was an Irish bishop, who in his time founded a great monastery at Clonfert on the shores of Kerry, and was the head of a confraternity, or order, of three thousand monks. The story of his transatlantic voyage is as follows: From the eminence now called, after him, Brendan Mountain, the saint had long gazed upon the Atlantic at his feet, and speculated on the perilous condition of the souls of the unconverted peoples who possibly inhabited unknown countries on the other side. At length, in the cause of Christianity, and for the glory of God, he resolved upon a missionary expedition across the ocean, although he was then well advanced in years. With this purpose he caused a stout bark to be constructed and provisioned for a long voyage, a portion of his supplies consisting of live swine. Taking with him some trusty companions, he sailed from Trawlee Bay, at the foot of Brendan Mountain, in a southwesterly direction. The voyage lasted many weeks, during several of which the vessel was carried along by a strong current without need of help from oars or sails. In the land which he ultimately reached the saint spent seven years in instructing the people in the truths of Christianity. He then left them, promising to return at some future time. He arrived safely in Ireland, and in after-years (mindful of the promise he had made to his transatlantic converts) he embarked on a second voyage. This, however, was frustrated by contrary winds and currents, and he returned to Ireland, where he died in 578, at the ripe age of ninety-four, and in "the odor of sanctity."

It would be idle to expect a plain, matter-of-fact account of St. Brendan's voyage from the chroniclers of the sixth century. The narrative is, in fact, interwoven with several supernatural occurrences. But, eliminating these, there remains enough of apparently real incident worthy of serious attention. The whole story, as already suggested, may be a mere pious fable promulgated and accepted in a non-critical and ignorant and credulous age. If substantially true, the fact could not be verified in such an age; if a pure invention, its falsity can not now be demonstrated. All that can be said about it is that it is in wonderful agreement with what is known, or may be inferred, from the Mexican legend. The story of St. Brendan's voyage was written long before Mexico was heard of, and, if forged, it could not have been with a view to offering a plausible explanation of a singular Mexican tradition. And yet the solution which it offers of that tradition is so complete and apropos on all material points as almost to preclude the idea of accidental coincidence. In respect to epoch, personal characteristics, race, religion, direction of coming and going, the Mexican Quetzatcoatl might well have been the Irish saint. Both were white men, both were advanced in years, both crossed the Atlantic from the same direction of Europe, both preached Christianity and Christian practices, both returned across the Atlantic to an insular home or Holy Island, both promised to come back, and failed in doing so. These are certainly remarkable coincidences, if accidental.

The date of St. Brendan's voyage—the middle of the sixth century—is conveniently within the limits which probability would assign to the period of Quetzatcoatl's sojourn in Mexico, namely, from about the fifth to the eighth centuries. The possibility of making a voyage in such an age from the western shores of Europe to Mexico is proved by the fact that the voyage was made by Quetzatcoatl, whatever part of Europe he may have belonged to. The probability of St. Brendan designing such a voyage is supported alike by the renown of the saint as a "navigator," and by the known maritime enterprises and enthusiastic missionary spirit of the Irish of his time; the supposition that he succeeded in his design is countenanced by the ample preparations he is said to have made for the voyage.

There is a disagreement between the Mexican tradition and the Irish narrative in respect to the stay of the white man in Mexico. Quetzatcoatl is said to have remained twenty years in the country, but only seven years—seven Easters—are assigned to the absence of St. Brendan from his monastery. Either period would probably suffice for laying the foundations of the Christianity the remnants of which the Spaniards found in the beginning of the sixteenth century. On this point the Irish record is more likely to be correct. The Mexican tradition was already very ancient when the Spaniards became acquainted with it—as ancient as the sway of the vanquished Toltecs. For centuries it had been handed down from generation to generation, and not always through generations of the same people. It is, therefore, conceivable that it may have undergone variations in some minor particulars, and that a stay of seven years became exaggerated into one of twenty. The discrepancy is not a serious one, and is in no sense a touchstone of the soundness of the theory that Quetzatcoatl and St. Brendan may have been one and the same person.

A curious feature of the Mexican tradition is its apparently needless insistency upon the point that Quetzatcoatl sailed away from Mexico in a vessel of serpents' skins. There seems no special reason for attributing this extraordinary mode of navigation to him. If the design were to enhance his supernatural attributes, some more strikingly miraculous mode of exit could easily have been invented. The first impulse, accordingly, is to reject this part of the tradition as hopelessly inexplicable—as possibly allegorical in some obscure way, or as originating in a misnomer, or in the mistranslation of an ancient term. But further consideration suggests the possibility of there being more truth in the "serpents' skins" than appears at first sight. In the absence of large quadrupeds in their country the ancient Mexicans made use of serpents' skins as a substitute for hides. The great drums on the top of their temple-crowned pyramids were, Cortes states, made of the skins of a large species of serpent, and when beaten for alarm could be heard for miles around. It may, therefore, be that Quetzatcoatl, in preparing for his return voyage across the Atlantic, made use of this material to cover the hull of his vessel and render it water-tight. The Mexicans were not boat-builders, and were unacquainted with the use of tar or pitch, employing only canoes dug out of the solid timber. When Cortes was building the brigantines with which he attacked the city of Mexico from the lake, he had to manufacture the tar he required from such suitable trees as he could find. Quetzatcoatl may have used serpents' skins for a similar purpose, and such use would imply that the vessel in which he sailed away was not a mere canoe, but a built-up boat. If he was really St. Brendan, nothing is more likely than that he should seek for a substitute for tar or pitch in skins of some sort. Coming from the west coast of Ireland, he would be familiar with the native curracles, coracles, or hide-covered boats then in common use (and not yet wholly discarded) for coasting purposes, and sometimes for voyages to the coasts of Britain and the continent of Europe. Some of these were of large size, and capable of carrying a small mast, the body being a stout framework of ash ribs, covered with hides of oxen, sometimes of threefold thickness. It may have been a vessel of this kind which Quetzatcoatl constructed for his return voyage, or it may be that he employed the serpents' skins for the protection of the seams of his built-up boat in lieu of tar or pitch. In any case the tradition makes him out a navigator and boat-builder of some experience, and if he were really St. Brendan he would have had a knowledge of the Irish mode of constructing and navigating sea-going crafts, and would probably have employed serpents' skins, the best Mexican substitute for ox-hide, in either of the ways suggested.

In the Mexican tradition there is no certain reference to Quetzatcoatl having with him companions of his own country, though in the story of St. Brendan the Irish saint is given such companions both in his going out and coming back. But the Mexican tradition nowhere negatives, either by implication or directly, that Quetzatcoatl had companions of his own race, and it seems in the highest degree improbable that he could have crossed the Atlantic both ways alone and unassisted by comrades. It may, therefore, be supposed that the fact of Quetzatcoatl having attendants of the same religion and nationality as himself was a detail omitted from an account which chiefly concerned itself with the great figure of Quetzatcoatl himself.

It would be presumptuous to claim that the identity of Quetzatcoatl with St. Brendan has been completely established in this essay, but it may reasonably be submitted that there is no violent inconsistency involved in the theory herein advanced, and an examination of the evidence upon which it is based discloses many remarkable coincidences in favor of the opinion that the Mexican Messiah *may* have been the Irish saint. Beyond this it would not be safe to go, and it is not probable that future discoveries will enable the identity of Quetzatcoatl to be more clearly traced.—*Gentleman's Magazine.*

THE EDUCATION OF CHILDREN.

IN studying the plans laid down by Friedrich Froebel for the education of young children, one is reminded of a passage in his letter to Krause, where he says:

> Here there budded and opened to my soul one lovely bright spring morning, when I was surrounded by Nature at her loveliest and freshest, this thought, as it were by inspiration: That there must exist somewhere some beautifully simple and certain way of freeing human life from contradiction, or, as I then spake out my thought in words, some means of restoring to man himself at peace internally; and that to seek out this way should be the vocation of my life.

Froebel in his own childhood had suffered much from this contradiction in life. He had a severe father and an unsympathetic step-mother; and had himself felt the ill effects of a stern and rigid rule, which merely required conformity to the given law without inquiring if conformity were possible. He had found this kind of rule a hindrance to true development, inasmuch as organic growth can not take place according to rules prescribed from without, but only according to the natural law. Gradually the idea took shape in his mind that this contradiction was not a necessary condition of life, that the soul and the outer world are not meant to be forever at war, that when we have learned to live aright this conflict will cease and they will be at one.

The idea of the introduction of harmony into education and into life seems to be the keynote of all Froebel's teaching. At the time that the thought above quoted from the letter of Krause first came to him he had not as yet realized that this harmony might be effected by a change in education; he came gradually to see that the object for which he was striving was the substitution of development for repression and arbitrary rule. He says again in the same letter:

> My experience, especially that gained by repeated residences at the university, had taught me beyond a doubt that the method of education hitherto in use—especially where it involved learning by rote, and where it looked at subjects simply from the outside or historically, and considered them capable of apprehension by mere exercise-work—dulled the edge of all high true attainment, of all real mental insight, of all genuine progress in scientific culture, of self-contemplation, and thus of all real knowledge and of the acquisition of truth through knowledge. I might almost go further and say that its tendency was toward rendering all these worthy objects impossible. Therefore I was firmly convinced, as of course I still am, that the whole former educational system, even that which had received improvement, ought to be exactly reversed and regarded from a diametrically opposite point of view—namely, that of a system of development.

The principles of Froebel, when rightly understood, are not only a guide enabling us to form natural systems of education, but also a far-reaching criticism of life in general, teaching as they do that the ideal life is not one in which there is constant strife between the soul and the outer world, but one in which these are in harmony; that we must not waste our energies in striving to perform the impossible, but must rather work out our best impulses with integrity and without affectation. But while Froebel's principles are in theory equally applicable to the conduct of life and to methods of education, they are practically more easily applied to the latter, for the outer world in which our children live is less complicated and more easily regulated and arranged. We can not provide them with an ideal world, but we can do much more for them toward this object than we can for ourselves. Let it not be said that they will thus be unfitted for life in the world as it is. Rather will they be strengthened and enabled to take their places rightly therein—enabled also each in his own sphere and according to his strength to exert the right kind of influence upon the outer world and help on progress in the right direction.

A well-regulated *Kindergarten* is an example on a small scale of what life in the outer world ought to be. Each individual is encouraged to exercise choice in all cases where it is not hurtful to the community, and no one is compelled to do disagreeable things for the sake of what is so often falsely called discipline. The children are not asked if they are good or told that they are bad. They are not encouraged to think about themselves at all, but the moral feelings are unconsciously developed because there is an atmosphere of sympathy and happiness. Fear, the most common cause of untruthfulness in children, is entirely removed, and the nature of the surroundings is such as to gradually diminish other causes, such as boastfulness and selfishness. The teacher watches the children and makes use of their own natural tendencies to further the objects which he has in view. He works with them, constantly helping and encouraging, gently turning their efforts in the right direction, and never takes up the position of a cold and rigid martinet. A child who does not succeed in anything he is trying to do is not punished and generally not blamed; but the children are not idle, because they are interested in their work, and because success is always preferable to failure. On the moral as well as on the intellectual side, the teacher does not make demands upon the powers of the children which are not likely to be satisfied. Right action in this matter requires sympathy, judgment, and experience. It is hurtful to the moral nature to be asked to perform a good action of which that nature is not yet capable, but it is by the performance of that which is within its powers that the moral nature is strengthened and developed. Thus the child learns by doing, and moral progress becomes a steady development instead of a constant struggle between duty and inclination. This is the only way of reaching that absence of effort which is as necessary to a harmonious life as it is to a work of art. It also tends to produce in every individual a certain true simplicity of nature, which in a sense makes every one a genius by freeing him from the bondage of a dull conventionalism.

The same principles apply on the intellectual side of development. One must not set up an arbitrary standard before the child and crudely expect him to attain to that. In short, we must find something which he can do, and not peremptorily order him to perform things which are impossible to him. What is the right cure for idleness? First of all it may be safely stated that punishment is *not* the cure. Idleness is generally a sign either that the work is too difficult or that it is unsuited to the child. Very few children will prefer doing nothing to suitable occupation; and those few are in an unhealthy condition, probably caused by previous mismanagement. A head master remarked not long ago in a speech on prize-day that he had often seen an apparently dull boy changed into a bright, happy one, by being set to practical work in the laboratory. When children are dull, it is the business of the persons who are educating them to find out why they are dull, and apply the right remedy. The children can not find it out for themselves, any more than they can discover the causes and cures of their bodily ailments. They often have a vague sense that they are not being treated fairly, and in some cases they even learn to regard teachers as their natural enemies.

The fact is, that not only is teaching useless when it fails to arouse interest, but it is injurious to the moral nature as well as to the mind. An ignorant boy is a less unsatisfactory object than one crammed with undigested information. One does not know how to begin to improve the latter; he seems a hopeless case; he is persuaded that all school-books are unutterably dull, and never opens one if he can avoid doing so. When this state of mind is once produced it is difficult to alter it. Probably it can only be altered by giving up school-books entirely for many months, and putting the boy to some totally new occupation. But it is by no means an impossible task to prevent its being produced at all. In a *Kindergarten* a child's mind never gets into this state. There is a steady development which should be continued throughout the period of education. The pressure of contradictions—which is incompatible with real moral and intellectual progress—should never be introduced.

One of the problems of the present time is the successful application of Froebel's principles to the education of children beyond the age for the *Kindergarten*. Owing to the fact that the attention of teachers has been more frequently directed to the practical working out of Froebel's principles so far as young children are concerned than to the general principles themselves and their application to the training of older children, we have not yet a good system of training for children too old for the *Kindergarten* and too young for the grammar school. In many *Kindergartens* there are classes for children who have reached this stage, and an attempt is made to carry on the system; but the teaching is apt to be a little too childish, to fail in rousing fresh interests and not to develop sufficiently the energies of the children. Yet it appears to be less injurious than that often given to children between seven and fourteen years old in the junior classes of grammar schools and high schools, where tasks are too often set which are beyond the powers of the children, or fail to arouse their interest, in some cases even producing a feeling of positive disgust toward all kinds of school-work. A few months of such teaching often destroys the effect of years of careful and wholesome training. The child learns nothing which is of any real value, and his whole moral nature is strained and irritated. Perhaps fear of the teacher is added to the other difficulties of the case—and yet it would not be fair to blame him too severely. It is difficult for masters who are inexperienced in teaching, and fresh from the university, to understand and sympathize with the requirements of minds at a stage of development so different from their own. In many cases they are doing their work as well as they know how to do it; but they have undertaken a difficult task, and often have no idea of the care which is needed to perform it rightly. True sympathy with children is chiefly found in the young who can remember their own childhood distinctly, and in those who are old enough to have the feelings of a parent toward them. A few men, and more women, have it throughout life. It would not be possible, however, to select a person less likely to have sympathy with a child than a man between the age of twenty and twenty-four, who has lately been giving all his attention to the development of his own mind. As this is the kind of teacher boys under twelve years old generally have in grammar schools, the result is naturally not satisfactory. But the fault is more in the system than in the individual teacher.

It is not yet generally recognized that the younger a child is, the more important is the training which he receives. Froebel realized this fully, and wisely applied himself to working out in detail a good system of training for very young children. In our time a system of wholesome training for children between seven and fourteen is still urgently needed. It is beyond the scope of the present paper to enter into detail as to what this training must or must not be. But some points may be mentioned. (1) There must be the regular performance of some kind of useful work suited to the age and capacity of the child. (2) Book-learning must be given up in the case of any child to whom it can not be made pleasurable. (3) Prizes must not be given for success in school-work, nor punishment for failure. (4) The natural love that children have for games must be taken advantage of, so as to cause a healthy development of the moral nature, the physical powers, the imagination, etc. (5) The energies of the child must be fully as well as harmoniously developed, and the child's growth must not be stunted by too easy work. (6) A love of nature and of all forms of beauty must be stimulated and encouraged.

The difficulty of establishing a natural system of education is much increased by the anxiety on the part of parents to see at every point evidence of their children's progress. This natural but inconvenient wish has prevented the *Kindergarten* system from coming more generally into use, and unless parents can be induced to place more confidence in the capacity and judgment of teachers, it is to be feared that it will also prevent the introduction of improved systems of training for older children. In inspecting schools for young children an examiner should make it his business to find out whether they are being taught in the right way, not whether they have reached a high standard of book-knowledge. The latter is of little or no importance, the former is all-important. We should not hear so many protests against examinations if examiners knew how to do their work rightly. At present examiners think it is their business to find out what the children know, and so long as that is the case examinations will not be satisfactory. Are the children's minds in a healthy state and are their faculties being drawn out in the right way? These are the questions that need attention. An examination should be so conducted as to avoid developing self-consciousness and other morbid tendencies. We want to teach the children to be, not to seem. More freedom is needed both for teachers and children. Perhaps it may not be thought safe to grant the freedom; that has often been the case in history, and yet the grant of freedom has been generally justified by its results.

Frequent examinations prevent natural growth. We do not expect our gardeners to show us the roots of their growing plants. A child's attention should be fixed if possible more on the subject of study itself than on his own progress in it, and examinations as they are now conducted are apt to prevent this. They are less injurious to older children when an interest in the subjects themselves has been firmly established. But all examinations tend to encourage the performance of work in order to show what one can do, which is not a good motive for human conduct. It is wholesome to work from interest in a subject, or in order to help others, but not in order to show that we can do well, still less that we can do better than others. An object of this kind tends to destroy that "harmony of life," that "peacefulness of heart," the attainment of which for himself and others was Froebel's chief object. In our time, when the conflict of life seems to be constantly increasing, this harmony and peacefulness seem to be further off than ever. It is more difficult to introduce harmony into complicated than into simple forms of life. We have had many writers of pretty ballads, but only one Shakespeare. In past generations there were many people who lived harmonious but narrow lives, the men pursuing the same occupations which their fathers pursued before them, and the women chiefly occupied with household concerns, thus quietly passing through a life of calm content without hurry or striving. Many of them worked out in their lives the saying that "to do is better than to know," though perhaps if they had heard it they would hardly have understood it. But this kind of life has become impossible, and the problem now is how to introduce unity into the turmoil of modern life.

Like Froebel, when a problem of the same kind presented itself to him, we turn to a change in education for its solution. Much may be done by training children to value things in their right proportions from the first, and by encouraging them to preserve the simplicity and reality of childhood, instead of exchanging them for the shams and conventions of "grown-up-land." Our faith ought not to be less than that of Froebel. It is true that the conditions are now more complicated, but on the other hand the world is now beginning to awake to the immense importance of right education. We are now taking pains to find out what is really wanted in the lives of the poor, instead of trying to force upon them things which we think they ought to want, so that many lives, which would otherwise be very narrow, are gradually being widened in a wholesome way. It is going out of fashion to offer to people, because they are poor, mental and moral food which the givers would decline if offered to themselves. In short, there is more reality than at any former period in the efforts of the rich to help the poor, and an earnest attack is being made in this direction on the contradictions of life. There are many among the rich who are painfully oppressed by the weight of luxuries, which it appears impossible under present conditions to share with others, and are making earnest endeavors to find out the right kind of mercy which shall really bless him that gives and him that takes. It is found that something can be done by offering opportunities for culture, for innocent enjoyment, for participation in simple pleasures, and, to those who are capable of it, for deeper thought. So that here also we find in wholesome education a lessening of the contradictions of life.

And just as a thoughtful teacher learns nearly as much from his pupils as they learn from him, so do those who are engaged in widening the lives of the poor find themselves refreshed and strengthened by the wholesome simplicity, practical common sense, and steady patience which are so often found among those who spend their lives in hard manual toil. Steady work teaches many lessons which can not be learned in any other way, and when it does not absorb the whole nature, and is such that the worker can take pleasure in it—it is wholesome training. So much is this the case that perhaps what is most needed just now for the children of those who are not poor is this same manual work, if only for a short time every day. In this would be found a cure for many of the nervous diseases which are so common. It would give some knowledge of the nature of the objects with which we are surrounded, and the right feeling of respect for labor which it is difficult to give in any other way. It would develop the physical powers and the natural tendency which children have to help others, a tendency which is very insufficiently developed at present. The work must be useful—one kind of useful work being of course the production of beautiful things—or it will fail in its chief object. The child must not think it is done entirely for his sole benefit, and therefore it must not be done solely for that purpose, as it is no part of sound education to deceive a child for his supposed good.

In a well-conducted *Kindergarten* the childen do work which fulfills these conditions so far as it is possible to do so at their age. The right kind of beginning is made. As they get older they should learn to do harder work and work of a more practical kind, and also continue the endeavor to produce beautiful things. There is no kind of useful work which can not be made a pleasure to the worker if set about in the right way. Froebel, in writing of his childhood, mentions the advantage he received from helping his father and mother in gardening and in household occupations.

As in intellectual work, it is very important not to make too large demands at first upon the powers of the child. The development of his powers must be gradual and will then be pleasurable. If a feeling of despair is allowed to arise, progress becomes impossible until the happiness of the child is restored by encouragement. Pleasure and trust in the teacher are necessary conditions of development. Nothing satisfactory can be accomplished by a teacher without close sympathy with and love for the child. An attempt to further the development of a human being by harsh rule and stern command, with threats of punishment, is like pulling the branches of a tree to make them grow. If the tree be firm and strong, no effect is produced beyond some slight damage to the branches; but if the tree be young and tender, its delicate roots are bruised and broken. Growth does not come by force. The right conditions must be supplied, the right food offered, and then the growth will take place naturally and freely. It is most true, as Froebel points out, that plant-life teaches many lessons about education.

In child-nature there is an infinite variety, and sympathy with the special needs of each individual is necessary for right development. We want to lighten somewhat the pressure of custom which lies upon us with a weight

"Heavy as frost and deep almost as life,"

and to bring out in every child something of that fresh originality of mind which, when it is found, makes even ignorant persons agreeable companions and useful members of society, and which is also the first condition of brilliant success in all work.

Nature is a great healer and sets many crooked things straight. A child's mind, when working under reasonably free conditions, seizes upon that which it requires and disregards that which is unnecessary or hurtful. There is some tendency on the part of teachers in the *Kindergarten* not to realize this quite sufficiently, and consequently to make their system a little too artificial. It is not satisfactory to bind one's self down too rigidly to one method however good. The laws of mental development are at present very imperfectly understood. Growth often takes place in unexpected ways, or does not take place when we should expect it. The order of development is less rigid and more variable than is sometimes supposed. If this were not the case, there would be more difference than there is at present between a child educated in a *Kindergarten*, and one educated in a well-ordered home. In the home the objects present themselves to the child without any fixed order—he tumbles into knowledge; and this want of system is not without its advantages, seeing that we can not make our systems perfect. Even if a definite system be pursued, some time and opportunity must be given at all stages of education for this chance development. In a home where a child is allowed, under the care of some educated person, to investigate the objects around him and the natural and artificial processes which are conducted in the house and its surroundings, much healthy development may take place without any fixed system. But a life which is limited to the nursery with artificial playthings and a daily walk by the side of a perambulator is eminently unsatisfactory. An ignorant nurse has no idea of the kind of sympathy and help a child requires. Even when she is fond of him she interrupts the workings of his mind with rude laughter. She does not understand how to speak the truth, though if convenient she will stigmatize an unintentional misstatement as a lie. She will capriciously surround him with vexatious restrictions, yet will develop self-consciousness and selfishness by flattery and over-indulgence. This is not a promising state of things; but a determined child, especially if he be fortunate enough to have brothers and sisters, will modify it somewhat by engaging in active and healthy play whenever he can elude the vigilance of his nurse, who is full of anxiety about the state of his clothes, and disapproves of most kinds of games. In a house where a reasonable amount of freedom is allowed, and where the children are intelligent and active in mind and body, they will, unaided by their elders, carry on their development by means of games in a fairly satisfactory manner. This part of education is, however, better managed in a *Kindergarten* than anywhere else. Opposing tendencies are woven into harmony by the experienced teacher, suggestions are made when required, and the needs of all the children are duly considered. Every child takes part according to his ability, and no one is forgotten or neglected. The children are perfectly happy, because they are not indulged too much or overexcited, and the performance is as different from the proceedings at an ordinary children's party as Milton's "heart-easing mirth" from his "vain deluding joys."

We owe to Froebel the first recognition of the high purpose in children's play, and the idea of ordering and arranging it so as to form a harmonious development according to Nature's methods. Full of sympathy with child-nature, and having himself a child-like simplicity of mind, he saw that true education is not the suppression of natural tendencies, but their wholesome encouragement. The outside life of the world has many inharmonious elements. In these children's games we have a little image of the world with the inharmonious elements eliminated. Joining in them is a training for living the right kind of life. The children do not talk about living rightly, but they do it. This is the best preparation for the right use of a wider experience.

A teacher of ethics better known than Froebel taught that the first condition of right life was to "become as a little child."

Note.—In quoting from Froebel's letter to Krause, the English translation by Emilie Michaelis and H. Keatley Moore has been used.

—*Macmillan's Magazine.*

A curious series of coincidences is noticed in Dr. S. T. Hickson's Naturalist in North Celebes. The island is a frontier point between Malaysia and Melanesia, and is situated linguistically almost where the Papuan, Melanesian, and Malayan families of speech meet. It is further, at the same time, the home of a marsupial sloth, the *Cuscus celebensis*, which has the characteristics of the Australian fauna, and of a tailless baboon, the *Cynopithecus nigrescens*, African in its character. Thus the two most conspicuous mammals represent widely distinct zoölogical provinces. The marsupials there reach their northern and the *Cynopithecus* its southern limit.

SKETCH OF NIELS H. C. HOFFMEYER.

TO Captain Niels Hoffmeyer meteorology owes some of its most important developments, and particularly the organization of what may be called the first ocean weather service.

NIELS HENRIK CORDULUS HOFFMEYER was born in Copenhagen, Denmark, June 3, 1836, the son of Colonel A. B. Hoffmeyer, and died in Copenhagen, February 16, 1884. It was at first intended that he should pursue a professional career, and his studies were begun with a view to that end; but the plan of his education was changed and he was sent to the military academy. He became an officer when eighteen years old, and was given an appointment in the artillery service when his course had been completed. His military effectiveness was impaired by a disposition to rheumatic fever, from which he had suffered in early youth, so that after having been engaged in the Schleswig-Holstein War he was prostrated again in February, 1864; and when the army was reduced at the close of that year he was placed on the retired list. Having spent a few months after his recovery in recruiting at the baths, in 1865 he visited France and spent a year in studying the methods and operations of the iron-foundries at Paris and Nantes. Returning to Denmark, he busied himself in furthering the establishment of similar works at Christiansholm, and while thus engaged was appointed to a post in the War Department and to be a captain of militia in Copenhagen.

His sojourn in France was contemporaneous with Leverrier's activity in meteorological research and experiments, under the impulse of which the principles that distinguish the modern methods in that science were largely developed. The publication of this student's daily weather map of all Europe in the *Bulletin International* had been begun only two years before. Hoffmeyer's attention was directed to the subject, and he entered into the study of it with an ardor that greatly redounded to the gain of science. He carried his newly aroused enthusiasm in this work into his war office, where he continued his studies; and when the Meteorological Institute was established in 1872 he was made its director. "There could scarcely be a more fortunate appointment," says Nature, to whose various articles we are chiefly indebted for the materials of this sketch, "for Hoffmeyer was gifted not only with unusual energy, but also with a very pleasant manner, so that he made friends for the new office and for its work wherever he went."

"It was from a singularly clear and firm apprehension of the characteristics of modern meteorology," Nature says in another article, "and an unflinching application of them to the facts of observation, that Captain Hoffmeyer has left his mark on the science—these principles being the relations of winds, temperature, and rainfall to the distribution of atmospheric pressure. In working out the weather problem of Europe, no country occupies a more splendid position for the observation of the required data than does Denmark with its dependencies of Faroe, Iceland, and Greenland. Denmark was slow to occupy the field, nothing having been done by the Danish Government prior to Hoffmeyer's appointment as Director of the Meteorological Institute. In a short time these important regions were represented by stations in Greenland, Iceland, and Faroe. The meteorology of Denmark proper was pushed forward with great vigor."

Of this work Mr. E. Ersley said, in an address to the Danish Geographical Society on the occasion of Hoffmeyer's death: "Hoffmeyer saw very early and clearly that our little country was of great importance in meteorology; for it lies between two seas, the North Sea and the Baltic, and exhibits a peculiar division of land and water, while storms sometimes originate in its precincts. For that reason we ought to endeavor to establish as many observing stations as possible. His efforts to accomplish this were embarrassed by the scantiness of the means allowed the Institute. But his practical sense came to his help, and he engaged a large number of private persons to erect stations where daily observations might be taken—at most of them without pay, and also at many without instruments except such as were privately furnished. In this way our country has been planted with not less than two hundred minor meteorological stations. He also saw that our further possessions, which were as good as unknown meteorologically, might be made members of extreme importance in the series of weather observations. He therefore secured meteorological stations in them—six in the Faroes, twenty-three in Iceland, and fourteen in Greenland, besides using his persuasive conversational powers to induce many ship-captains to take instruments on their voyages, especially on those to Iceland and Greenland."

Hoffmeyer labored at the Institute twelve years uninterruptedly for the advancement of meteorology, and, although suffering much in his later years from the effects of his rheumatic fever on his heart, with irrepressible energy.

In 1873 Hoffmeyer began the publication of the monthly Meteorological Bulletin of the North, and shortly afterward the issue of a daily meteorological chart for his own country, Norway, Sweden, and northwest Russia. To this chart was added an explanation for the use of subscribers. The work was found valuable by English meteorologists, because it supplemented their own daily weather charts and those of the *Bulletin International*, for a district extending from 63° east to 60° west longitude, and from 30° to 75° north latitude, whence accurate information was seldom obtainable by telegraph in western Europe. Although these charts did not at first repay the outlay made upon them, they were so well received by the meteorologists of Europe as to encourage their continuance. Their scope was enlarged in 1875, in accordance with the advice of the directors of various central institutions, so as to embrace a more considerable part of the globe, and give some idea of the distribution of temperature. Mercator's projection was discarded, in order to avoid the exaggerations of dimensions in northern regions; and other improvements in detail were made. These synoptical charts, giving observations made three times a day in Denmark, Faroe, Iceland, and Greenland, were continued for more than three years, or till November, 1876, at Captain Hoffmeyer's personal expense. Arrangements had been made in the summer of 1883 to resume the publication, in conjunction with Neumayer, and the first sheets of the new series were printed on the day after that of Hoffmeyer's death.

Captain Hoffmeyer was a worker in meteorology rather than a writer of papers and books on the subject. The service that he did is best seen in the organization of a system of stations at intervals across the ocean wherever his country had jurisdiction; in the conception of his synoptical charts; in the regular publication of the Meteorological Bulletin of Denmark, described in Nature as in several respects among the best that reached it; and in his co-operation in the formation and movement of the International Meteorological Congress. He was one of the secretaries of the meeting at Rome in 1876; and was a member, appointed by the Vienna Congress of 1873, and a secretary of the Conference for Maritime Meteorology that met in London in 1874. He also made some valuable literary contributions to the science. Among these are his papers on the Greenland Foehn, 1877, and on the distribution of atmospheric pressure in winter over the North Atlantic, and its influence on the climate of Europe, 1878. The former of the papers related to the sudden changes of temperature which mark the winter climate of Greenland, under which the mean temperatures of that season sometimes vary almost as much as 23° C. in different years, and Upernavik is sometimes as warm during the darkness of the polar night as the south of France. Sudden and sharp changes often occur several times in the course of the same month; and the rises always stand in connection with a veering of the wind to southeast and east. The phenomenon of a warm wind blowing from an interior which is covered with snow and ice has then to be accounted for. The older authors, to explain the paradox, resorted to imaginary volcanoes in action, or to the hypothesis of a comparatively mild climate in the interior—which it would be impossible to sustain on meteorological grounds; for the interior of every continent must necessarily be colder, by the effect of radiation, than the coast, where the sea is an ameliorating factor. Another attempted explanation depended on the Gulf Stream, whence the southeast winds were supposed to blow warm; but this, though reasonable, was insufficient.

When Hoffmeyer's attention was directed to these facts, his thoughts turned to other regions of the earth, and finally to the Foehn of the northern slopes of the Alps, where "a stormy southerly wind sometimes begins to blow very suddenly, which, from the snow-covered summits, hurls itself with irresistible force through the valleys which lead toward the north, and throws the Alpine lakes into frightful commotion. This wind, which is named Foehn, has, although it comes from a snowy region, an unusual warmth and dryness." At the same time that the southerly wind is found as an unusually warm and dry Foehn on the northern side of the Alps, a humid sirocco, generally accompanied by an enormous fall of snow, is blowing on the southern slopes of the mountains. This phenomenon had been accounted for by Dr. Hann, of Vienna, as the effect of the condensation, coming down from the tops of the mountains, of the air which had been cooled and deprived of its moisture by precipitation, in ascending the opposite slopes. Dr. Hann's calculations showed that the temperature of a south wind, lowered half a degree for every hundred metres of ascent, was raised one degree for every hundred metres of descent. These phenomena repeat themselves in Greenland. The author sketched in detail a Foehn period which lasted from eighteen to twenty days in the end of November and beginning of December, 1875, when Jakobshavn was for eight days warmer than north Italy. Unfortunately, direct observations from the uninhabited east coast of Greenland and the nearest parts of the Atlantic were wanting; but it was possible to show that during the same period a strong southeast wind blew from the sea over the land; for, according to the Buys Ballot law, the wind always blows so that it has the greater pressure of the atmosphere on its right, and, the more unequally the pressure is distributed, the greater is the velocity of the wind. Just during the eight days of heat at Jakobshavn, the barometer was much higher in Iceland than at Davis Strait. Over the tract lying between these places there had thus prevailed a strong southeast wind.

In the other paper, which is declared to be "an original and highly important contribution to science, whether regard be had to the method of investigation or to the results," Hoffmeyer showed that Greenland and Iceland exert a powerful influence on the distribution of atmospheric pressure not hitherto properly recognized, resulting in the mean minimum of pressure being localized distinctly in the south of Iceland—a minimum accompanied by two subordinate minima, one in Davis Strait and the other in the Arctic Ocean, midway between Jan Mayen and the Lofoden Islands. It was made plain, from typical charts giving the mean of four winter months, that one or the other of these minima plays the chief part, the other two being, for the time, subordinate; and that, according as one or the other of the minima predominates, so is the character determined, as regards mildness or severity, of the weather of the winter of the regions surrounding the north Atlantic.

An illustration of his method of working is afforded by the explanation he published of the causes of the cold weather that prevailed over Europe in May, 1874. He showed that a maximum of pressure had prevailed over northwestern and western Europe, "stretching like a great screen" between the Atlantic and central Europe, from Spitzbergen almost to Algiers, while the minimum came partly from the arctic seas, and partly from the western Mediterranean, with gradients steep toward the north and west Such a distribution of pressure must give rise to a cold polar stream flowing over the greater part of Europe. In Vienna the cold was greatest between the 16th and the 18th, and then the high pressure began to travel eastward, with the production of a great change, so that soon the pressure was lowest in the very district where a few days before the maximum had existed; and the temperature rose. A similar cycle of phenomena occurred in the next month. The author observed in this paper that areas of high pressure are much more quiet and longer lasting than minima, which travel rapidly, change their shapes, and throw off secondary disturbances.

The Meteorological Bulletin had become by the time of Hoffmeyer's death a very important and complete publication. In January, 1884, the number contained pressure results for thirteen stations, temperature for one hundred and nine stations, and rainfalls and other forms of precipitation for one hundred and fifty-nine stations; and these results were graphically shown on four maps, accompanied with a full descriptive letterpress—one map giving the isobars for the month, another the isothermals, and on the same map the mean temperature of each of the one hundred and nine stations; a third map, the miminum temperature at each of the stations; while the fourth map gave isohyetal lines, showing the rainfall, with the amount at each of the one hundred and fifty-nine stations entered in plain figures.

The most important results deduced by Hoffmeyer from his maps were contained in his pamphlet, *Étude sur les Tempêtes de* *l'Atlantique Septentrional et project d'un Service Télégraphique International relatif à cet Océan*, Copenhagen, 1880 (Study of the Storms of the Northern Atlantic, and Project for an International Telegraphic Service relative to that Ocean); "and up to the very last," says Nature, "he never ceased to use his utmost efforts for the establishment of a meteorological telegraphic service with America, *via* the Faroes and Iceland."

Besides enjoying the honors and positions already named, Hoffmeyer was Secretary of the International Polar Commission; an honorary member of the Royal Meteorological Society of London; and Danish Commissioner to the Fisheries Exhibition, in London, in the summer of 1883. While performing the duties of the last position, he complained of great weakness of the heart. He had suffered from occasional attacks of rheumatic fever; was ill for some time in December of the same year; and was finally attacked in January, 1884. He continued to work at the duties of his position, whenever he was able, till the last. His biographer, in Nature, says that, "to all who knew him, the memory of his eager readiness to assist fellow-workers, the urbanity of his manner, his joyous nature, and the unusual warmth of his friendship, can not but awaken the keenest feelings of regret for his early death."

Dr. J. Walter Fewkes exhibited to the National Academy of Sciences, at its recent meeting in New York, specimen reproductions of Indian sounds and music obtained by means of the phonograph. Some of the Indian languages are becoming extinct; the sounds of some can not be satisfactorily represented by any system of transliteration. The phonograph affords the only good means of preserving these. Cylinders were displayed containing records which the author had obtained last summer among the Passamaquoddy Indians of Maine and the Zuñis of New Mexico. From the former he had got sacred songs, religious rituals, folklore, and counting-out rhymes. Many of these will perish with this generation, for they are known to a few only of the older men. From the Zuñis he obtained in the phonograph their ancient religious rituals and formulas, their prayers, their songs at the corn-dance and other festivals, and their war-cry, which were reproduced for the benefit of the Academy. A difference was noticeable in the reproduction of the songs of the Passamaquoddys and of the Zuñis. Major Powell and Prof. E. S. Morse were of the opinion that the former was the music of one who had come in contact with civilization, while the latter was that of the aboriginal savage. The difference was in the intervals. It appeared by Dr. Fewkes's statement that the Maine Indians had been to a school and had learned from some "Sisters." The scale of Indian music, like that of the Zuñis, Major Powell said, can not be reproduced on our common staff, for they have intervals of one tenth, and even one twentieth. The Zuñi music had a sort of monotonous basis, broken by a succession of sharp sounds. Sometimes the movement was rapid, sometimes it was slower, but the essential characteristic was the monotone with lugubrious and unearthly variations.

CORRESPONDENCE.

ETHICS IN THE SCHOOLS.

Editor Popular Science Monthly:

SIR: There is evidently a wide-spread dissatisfaction with the lack of moral influences in our public schools. Religious people declare that the schools are godless, and are producing a generation of atheists. An earnest and growing class think that some modification of the school work should be made that would aim at developing every pupil into the noblest type of a human being. At present, from the lowest primary class to the university diploma, there is not a single study introduced that is designed primarily for the development of any side of character. Moral philosophy, to be sure, is taught in some higher-grade schools and in all the colleges, not for the purpose of making moral men and women, but that the student may know the theories about the existence of God, his relation to men, the basis of morals, freedom of will, etc.

Among those who are not actually opposed to moral teaching, we may recognize four groups, each occupying a different attitude toward this matter—the indifferent, the Roman Catholic Church, the Protestant Church, and scientists. The first class base their estimate of the value of a school upon its success in teaching those subjects that will help the pupil to satisfy his material wants. The question whether the school might not be made to accomplish a nobler end does not seem to concern them. Many of this class would not be disturbed by the introduction of instruction in ethics or even religion into the schools.

From the standpoint of the Catholic Church, the most important thing for a child to learn in this world is how to obtain salvation in the next. Nothing whatever should prevent him from gaining this knowledge. Hence they demand that religion should be taught in the schools, and, because the state schools do not provide for such instruction, the hierarchy has forbidden the children of the Church to attend them, and provides parochial schools instead. They are more strenuous for instruction in religion than in ethics, for the teaching of doctrine than of practical morals. Whether, if it were proposed to introduce instruction in ethics apart from religion, they would favor or oppose such a movement, is a question on which they have not expressed an opinion. To oppose it would seem to be a very inconsistent ground for a Christian body.

The Protestant Church has not yet defined itself so explicitly, but it evidently desires that the schools shall accomplish something better than what they are now doing. The fact that a conference of representatives from the Protestant denominations of New York State was recently held for the purpose of considering religious and moral instruction in the schools is very significant. This conference may be taken as fairly representing the leading sentiment of the Protestant Church in general. Some prominent clergymen present, like their Catholic brethren, would ask the state to give religious instruction; others equally prominent, either because they think that religion is not the province of the school or that it is hopeless to ask for religious instruction, were strongly opposed to this, but would perhaps rather favor carefully restricted instruction in Christian morals.

I have called scientists a fourth class. The term is used in this connection to designate those whose habits of study and thought are scientific rather than religious. They are not necessarily opposed to religion, but seem to have no use for it for themselves. The great advantage to the world which they see in religion is its ethics, but they derive their own code of ethics from another source. Whatever rules of conduct have been proved by experience to be for the good of man in our nineteenth-century civilization constitute the scientist's code of ethics. The question for him, then, in reference to the schools, is not whether any religious creed shall be taught, but, Shall instruction be given in pure, human ethics? Shall the children be instructed in the principles of conduct which have been tested and proved worthy of trust by centuries of experience? This very greatly simplifies the matter, which is hopelessly involved when connected with religion, and at the same time suggests a possible ground for compromise.

A grave difficulty in the way of a compromise is a general lack of definition between religion and ethics. The Church is the one institution which has demanded moral conduct of men. It has taught that eternal damnation is the penalty of wrong-doing and eternal bliss the reward of right-doing, *conjoined* with the acceptance of a certain belief. It has gone so far as to say that there is absolutely no saving virtue in kindness, in justice, in benevolence, in philanthropy of themselves—that there is no salvation in the next world except by means of a so-called "plan" drawn by the Church from Scripture. When an institution of such unmeasured power as the Christian Church has wielded for the past fifteen hundred years utters her dictum on eternal life and death, the world listens, because it believes in immortality. For this reason morality and religion throughout

Christendom have been confused and considered inseparable.

A clear distinction can be drawn, however, between Christian religion and Christian ethics. The Christian religion is the system of beliefs and worship drawn from the life and teachings of Christ. Christian ethics is the system of principles of human conduct drawn from the same source. By far the larger portion of Christ's teachings is devoted to telling men how to live and act, comparatively little devoted to telling them how to worship or what to believe. Whatever else he was, he was certainly a *great teacher of morals*.

The motive which Christ sets before men is, however, religious—viz., the hope of reward in the hereafter. But those principles of conduct which he enunciated, inculcating the spirit of forgiveness, humility, unselfishness, brotherly kindness, purity, charity, and chastity, together with his affirmative golden rule, if practiced, would make a paradise of earth, whether or not any regard was given to a hereafter. What we need in our schools is the direct instruction in such principles and their application to human conduct, and it matters not a whit whether we call them Christian, scientific, or pagan ethics.

If a scientist were to formulate a code of scientific ethics, and a Christian were to formulate a Christian code, the two codes would be strikingly alike. If the Christian were faithful to Scripture, however, he would have at least one point, which is embodied in one of the most fundamental of Christ's precepts concerning duty, that the scientist would not have, viz., "Resist not evil, but whosoever shall smite thee on thy right cheek turn to him the other also." If this had ever been tested in actual practice, it might belong to the scientist's code; but because of its severity as a rule of action theologists have spent much mental energy in explaining it away, and have so far succeeded that in its literal sense it is not generally considered as a part of Christian ethics—at any rate, no Christians practice it, unless perhaps Mr. Tolstoi. With this rule of action eliminated there is no important ethical principle which can form a ground of controversy between scientists and Christians. We assume that on ethical questions there is no material difference between Protestants and Catholics.

Since, then, the ethical codes of earnest scientific thinkers, of the Protestant, and of the Catholic Churches are substantially one, and since there is no hope that the state will ever teach religion in its schools, may we not hope that upon this ground as a basis of compromise something may be accomplished through the schools of vastly greater value to humanity than any degree of manual training or purely intellectual development? The large thoughtlessly indifferent class would certainly not object to such an innovation. Those who are opposed to religious instruction would not be losing their case, because ethics is not religion. All who desire religious instruction to be given would be gaining their object in part, inasmuch as they include ethics in religion. Why not, then, show a spirit of compromise, and, instead of fighting on hopeless lines with divided forces, unite on a platform on which all can stand and fight on lines where there is hope?

The Church is doing a magnificent work toward the correction of the monstrous evils that walk rampant, but it will do vastly more when it comes to place a higher estimate upon human character than it does upon creeds. A portion of the press is doing a grand work, but it will do tenfold more when the entire press comes to care more for cultivating public taste than it does for catering to it. But the schools, which cultivate the fields where richest and most abundant harvests might be reaped, are reaping exceedingly light and scanty harvests, simply because it is not their legal or professed business to do anything toward correcting existing evils or the formation of right character. B. C. Mathews.

86 Kearney Street, Newark, N. J.,
February 20, 1891.

EDITOR'S TABLE.

THE YOUNGEST OF THE SCIENCES.

To know is to be able, to *ken* is to *can:* philology proclaims it, and experience confirms it. Centuries ago the commoner phenomena of electricity and magnetism had attracted attention, but no one suspected that they meant anything in particular, or that they afforded indications of a power everywhere present, and only waiting a summons to enter into the service of man. Yet, let us not too severely blame our ancestors for lack of attention or intelligence. The doors of knowledge have had to be opened one by one, and in early times, when so many doors still remained closed, and others were at best but slightly ajar, it is not to be wondered at that the somewhat recondite and elusive laws of electricity should have remained unexplored. Even in our own century, what a long gap there was between the first production of the electric light and its application to practical purposes! It all seems very plain now, but two generations had to elapse before the electric light, as produced by Sir Humphry Davy in 1808, became available for general use. But if the progress made by electrical science was slow in its earlier stages, amends are truly being made now in the rapidity with which new views and new applications of electricity are crowding upon the world. The alleged miracles of olden time seem poor and commonplace in comparison with the miracles wrought by a little accurate knowledge. Here we have a power that has been in the world from the beginning, but from which, down to the present century, not one single valuable result was drawn, for the simple reason that we, or our predecessors, did not know how to use it, did not even know enough to recognize it in some of its manifestations. To-day, mankind has no more obedient, or, it may be added, capable servant. The early students of electricity had a task that closely resembled putting together a complicated puzzle of which there was no plan; but, as piece was joined to piece, the plan began to reveal itself, and subsequent progress was rapid. To-day, if the puzzle is not complete, at least we have, as far as it goes, a very symmetrical and intelligible pattern before our eyes.

It would be vain to attempt, within the limits of a brief article like the present, to give even a catalogue of the various applications of electricity now in daily use. Like chemistry, electricity has undergone a process of subdivision, and no one man can pretend to keep abreast of the latest developments in all its branches. The year 1837 saw the first telegraph for practical business purposes, and from that time to this there has been a constant stream of improvements in the methods and appliances of the telegraphic art. The whole world is girdled round and round with lines quivering with the impulses that translate the thoughts of men. Enormous as has been the extension of telegraph lines, well-nigh a million miles being now in use in this country alone, they would be utterly inadequate to the needs of the community but for the improvements that have been made in the way of duplex and multiplex telegraphy. The whole business of the world has adapted itself to the changed conditions which the telegraph has introduced. Without the telegraph the railway would be shorn of far more than half its efficiency, and the press of even metropolitan cities would shrink to provincial dimensions. It is becoming difficult to conceive what the state of business would be without even the telephone, which, in every large city, does the work of a whole army of messenger boys. How little we think of electricity when we press the button that closes an electric circuit and rings a bell! Yet the electric bell is certainly one of the most convenient of so-called modern improvements. Without it our great hotels, our public offices, our monster steamships would be much more difficult of management. Our signal service depends upon electricity to outrun the swiftest blasts of storm and herald their approach. The observations of the astronomer would lose much in precision were it not for the simple yet admirable instrument known as the chronograph. For all purposes of instantaneous registration, there is nothing equal to the action of electricity, the velocity of which is equivalent to that of light itself, and its applications for this purpose must go on increasing in number from year to year. Even as it is they are legion.

The electric light would seem to have furnished the world with the final and definitive source of illumination. It is not twenty years since even so good an authority as Prof. Tyndall spoke doubt-fully of the possibility of distributing the electric light from house to house; but to-day the problem does not present any greater practical difficulty than the distribution of water or gas. When Sir Humphry Davy first made an exhibition of the arc light he used for the purpose a battery of two thousand voltaic cells. Light so produced could never have come into general use on account of the excessive cost. Faraday had to formulate the laws of induction, and the dynamo had to be developed, before Davy's discovery could be turned to practical account, and even then a vast amount of ingenuity had to be expended in the arrangement of details. The incandescent light was a later development. An incandescent lamp is a simple thing to look at, but only those who have studied the subject know how much of laborious experiment and research it took to bring it to its present condition of perfection.

The dynamo which, practically speaking, gives us the electric light, gives us also electric traction and electric power generally. We are only beginning to realize the advantages which our new-found force may have in store for us in this direction. Every month the electric street car is more and more displacing the horse car, with added comfort to passengers and diminished wear of our thoroughfares. Power is conveyed silently over wires from central stations and distributed wherever it may be required for manufacturing purposes, saving a vast outlay in separate boilers and engines, and greatly economizing space. In great telegraph centers the dynamo is displacing cell batteries for the production of current. It is also used for electrolytic operations on a large scale. Nothing, perhaps, is more impressive than to witness the operation at the same moment and on the same spot of three distinct forms of force, mechanical or physical, electrical and chemical, one merging into the other. The water-wheel or the steam-engine furnishes mechanical power; the dynamo, taking up that power, converts it into electrical energy, which again, conducted to an electrolytic cell, is further changed into chemical action. Nothing could more powerfully bring home the lesson that, in the last analysis, all energy is one. Vast industries would disappear from the earth if the various applications of electrolysis could by any means be lost—electro-plating, electrotyping, electro-metallurgy, and a hundred other special applications of electro-chemistry. It takes a considerable effort of thought and memory to realize the extent to the every-day operations of the modern world are dependent upon a power which but a few generations ago was a matter of more or less crude speculation and idle wonder. In electro-welding we have a process, strictly speaking, analogous to the production of the electric light; the energy of electricity is converted into heat at a given point with the most marvelous results. The new science is stretching forth its hands in every direction, and its achievements to-day are but an earnest of what it is destined to accomplish in the near future.

There is, however, another aspect of the matter which is deserving of attention. From having been, up to a short time ago, a subject concerning which the most vague and confused ideas were generally entertained, electricity is now furnishing matter for the formation of one of the most exact sciences. It is true there is a vast amount of popular ignorance respecting it still; one might not, perhaps, have far to go to find "educated" people who imagine that Edison and electricity are almost convertible terms, or at least that electricity was fished bodily out of the depths of the unknown by Edison; nevertheless, the light is spreading, and the very operations which the applications of electricity involve are furnishing a valuable education to a large section of the community. Electricity is above all things measurable, and measurable in a great variety of ways; and the measurement of electricity implies the investigation from a new standpoint of the various substances used as its conductors. The study of this particular agency, therefore, involves the study of a great number of related things, and thus directly tends to an enlargement of mental grasp. It has, if we mistake not, another most interesting side. All natural sciences, by the analogies they supply, throw more or less light upon the operations of mind and the movements of social forces. Electricity, we believe, will furnish the most instructive ones of all, but we can not to-day more than throw out the hint. Physical science, let us say in conclusion, is bringing noble gifts to the feet of mankind; it is for mankind to see that they use these nobly and wisely.

THE DOCTRINE OF NATURAL SELECTION.

THERE has been a very industrious outcry in certain quarters lately, to the effect that the doctrine of Natural Selection was losing ground; and certain reactionaries have been allowing themselves to entertain great hopes that all might yet be well with their antiquated ideas. As a very apt and powerful answer to this contention came Mr. Wallace's book on Darwinism, in which, in the line of animal creation, he claimed more for the action of natural selection than even Darwin had done. Following close on it came the interesting treatise of Mr. E. B. Poulton, F. R. S., on the Colors of Animals. The last paragraph of Mr. Poulton's preface is worth quoting entire:

"Above all, I should wish to acknowledge, although I can never fully express the depth of my indebtedness to the principles which first made Biology a science, the principles enunciated by Charles Darwin. It is common enough nowadays to hear of new hypotheses, which are believed by their inventors to explain the fact of evolution. These hypotheses are as destructive of one another as they are supposed to be of natural selection, which remains as the one solid foundation on which evolution rests. I have wished to express this conviction, because my name has been used as part of the support for an opposite opinion, by an anonymous writer in the Edinburgh Review. In an article in which unfairness is as conspicuous as the prejudice to which it is due, I am classed as one of those 'industrious young observers' who 'are accumulating facts telling with more or less force against pure Darwinism.' On the strength of this and other almost equally strange evidence, the reviewer triumphantly exclaims, 'Darwin, the thanes fly from thee!' In view of this public mention of my name, I may, perhaps, be excused for making the personal statement that any scientific work which I have had the opportunity of doing has been inspired by one firm purpose—the desire to support, in however small a degree, and to illustrate by new examples, those great principles which we owe to the life and writings of Charles Darwin, and especially the pre-eminent principle of natural selection."

Mr. Poulton may express himself, perhaps, a little over-enthusiastically; but surely there is much significance in the protest which he raises against being quoted on the anti-Darwinian side. One substantial piece of manufactured evidence not only vanishes entirely, but has its place taken by an energetic assertion of the contrary position. Evidences, indeed, that the doctrine of evolution has become almost a fixed principle with scientific workers are to be found on every hand. When men of any scientific eminence whatever, like the late Prof. Sedgwick, in England, or Sir William Dawson, of Canada, refuse it their adhesion, their position becomes one of such singularity as powerfully to prove the rule as to the direction the scientific world at large has taken. One of the most conservative publications of the day in England is the Quarterly Review, and this is what we find in the very last number of that periodical on the subject of Sedgwick's non-acceptance of the modern standpoint in geology: "In coordinating the vast array of (geological) facts so as to form out of them a basis for the great cosmical theories which are the inheritance of his successors, he lagged behind his more philosophical contemporaries. He never broke loose from the entanglement of attempted reconciliations with the biblical cosmogony, never ceased to invoke 'successive creations of the organic kingdoms' to account for the order of life revealed in the rocks and clays. Lyell's great generalization of uniformity was always a stumbling-block to him, and evolution in every shape was to the end hated by him with a perfect hatred. It was years before he could discard the puerile idea that the 'vast masses of diluvial gravel scattered almost over the surface of the earth' were all due to the single catastrophe of the Noachian Deluge; and not till after half a century of geological study could he bring himself to ascribe any validity to the evidences for the vast antiquity of the human race, as contrasted with the historical period." The Quarterly Review, in spite of its general conservatism, is evidently in line with modern thought on these subjects. All the more amazing is it that some men should be found to talk as if the old conceptions were still valid, and the work of the evolutionist school had been in vain.

LITERARY NOTICES.

A Handbook of Descriptive and Practical Astronomy. By George F. Chambers, F. R. A. S. Fourth edition. New York: Macmillan & Co. (Three volumes.) Pp. 676, 558, 384. Price, $14.

For a quarter of a century Chambers's Handbook of Descriptive and Practical Astronomy has been in the hands of all English-speaking astronomers, and has maintained its ground as a valuable book of reference and an interesting summary of astronomical knowledge. In the fourth edition, now issued, the author has divided the work into three separate volumes, treating respectively of The Sun, Planets, and Comets; Instruments and Practical Astronomy; and The Starry Heavens. Each volume has its own independent index and paging. The author's reason for splitting up this well-known book is that so much expansion was required in order to bring it up to date that a single volume of convenient size could no longer contain the matter.

Three or four features of the work may be at once pointed out as especially useful and interesting to amateur astronomers. These are the catalogues of comets and the historical account of eclipses of the sun in the first volume; the elaborate description of telescopes and other instruments used by the astronomer, and the account of chronological astronomy in the second volume; and the photometric catalogue of naked-eye stars in the concluding volume. The compact chronological sketch of astronomy in tabular form, given in the second volume, may also be mentioned as very convenient for reference. This could have been made far more satisfactory, however, if the author had taken the trouble to insert, in all cases, the Christian as well as the surnames of the many astronomers included in his lists.

The whole work is, of course, a compilation, drawn from every available source, and, on account of the somewhat heterogeneous nature of much of the material of which it is composed, lacking in that perfect unity of composition which, when present, gives an irresistible charm to a book. But the author probably had no thought of writing a work that should attain great popularity among mere readers. His intention was to furnish, as his title implies, a handbook or guide-book of astronomy, rich in information and as complete as possible in the matter of reference. The bottoms of his pages are, indeed, filled with a great variety of references to authorities, which can not fail to prove very useful to the student. He has also drawn his illustrations from many sources—German, French, Italian, and American, as well as English—and has only left it to be wished that he had included some of the photographs that have within the past few years thrown such a flood of light upon celestial phenomena. The old pictures of spiral nebulæ are hardly worth retaining, except for the purpose of comparison, when such photographs as those of Mr. Roberts, the Henry Brothers, and others are obtainable. An interesting feature of the illustrations retained from the preceding editions is the series of pictures of double and multiple stars. These are of material assistance to the amateur in observations of close doubles whose components can barely be separated by the highest powers of the telescope. In this edition the stars in the picture of that wonderful vari-colored cluster which Sir John Herschel discovered near Kappa Crucis, and which he compared to a casket of many-hued gems, have been represented of their proper colors, and the effect is both pleasing and instructive.

The catalogues of binary and multiple stars, and of variable, red, and temporary stars, add much to the usefulness of the volume devoted to the starry heavens.

We are acquainted with no book that contains so much practical information for the amateur about the instruments of the astronomer, their construction, and the methods of mounting and using them, as does the second volume of Mr. Chambers's work. This information ranges from the magnifying powers of different forms of eye-pieces and the proper adjustment of object-glasses to the construction of observatories and the discussion of the best methods of adjusting and mounting telescopes, transit instruments, astronomical clocks, and so on. There is a great variety of practical hints and directions for the guidance of the amateur in the actual work of observation.

In view of the great development of popular interest in astronomy which the past ten years have witnessed, such a work as this must find a rapidly increasing circle of readers; and the author was probably wise in enlarging its scope, in the face of the great increase of cost involved in the change from one volume to three.

Ninth Annual Report of the United States Geological Survey, 1887–'88. J. W. Powell, Director. Washington. Pp. 717, quarto.

In reviewing the work of the many divisions of the Geological Survey during its ninth year, the director states that topographical surveys covering 52,062 square miles have been made by the Division of Geography. The largest areas were surveyed in Missouri, New Mexico, Virginia, Texas, and Arkansas. In Massachusetts, the survey undertaken in co-operation with the State authorities was completed. The examination of the swamp and marsh lands along the Atlantic coast south of New York was continued. These lands, "deleterious to health in their natural condition, an obstacle in the way of approach to the sea, repellent to the settler, to agriculture, and to manufactures, they yet hold out the hope of highly productive utilization through the judicious application of capital." Investigations were carried on also in many other localities, and much laboratory and office work was done. The director gives sketches of the life-work of four prominent members of the survey whose deaths occurred during the year, namely, F. V. Hayden, R. D. Irving, James Stevenson, and Thomas Hampson. Reports from the several chiefs of divisions give the details of the work in their several departments. Of the papers accompanying the director's report, the most extended one is on the Charleston earthquake of August 31, 1886, by Captain Clarence E. Dutton. The chief result obtained from this study is a close approximation to the rate at which an earthquake wave moves, and this is found to coincide with the theoretical rate. Although severe labor was expended for many months in an attempt to obtain some information respecting the cause of earthquakes, the data yielded nothing on this point. The monograph is introduced by accounts of the earthquake by three residents of Charleston who experienced it. One of these, by Mr. Carl McKinley, of the News and Courier, was prepared for the annual report of the city government. Dr. G. E. Manigault, of the Charleston College, was selected to prepare an account especially for this record, and the third was written by Mr. F. R. Fisher. The following chapters embrace detailed studies of the local effects of the earthquake and of the epicentral tracts, a summary view of the effects throughout the country, a computation of the depths of the foci, and discussions of the isoseismals, the speed of propagation through the ground of the principal vibrations, and the nature of wave-motion through solid bodies. Two epicentrums were found—one near Woodstock, about sixteen miles northwest of Charleston, the other almost due west of the city and about thirteen miles distant. In the investigation of the tracts around these points Captain Dutton gives high praise to the labors of Mr. Earle Sloan, of Charleston. The paper occupies three hundred and twenty-eight pages, and is copiously illustrated with views of ruined buildings, displaced tracks on the railroads, fissures and craterlets in various places, and with maps and diagrams. Prof. N. S. Shaler contributes to this volume a report on The Geology of Cape Ann, Massachusetts, comprising the general structure of the district, its superficial geology, the structure and nature of the bed-rocks, and the relations of the region to the anticlinal axis of which it forms a part. This paper also is fully illustrated. There is an account of the Formation of Travertine and Siliceous Sinter by the Vegetation of Hot Springs, prepared by Walter H. Weed, which is illustrated with many views of the springs in the Yellowstone National Park. The volume includes also a report On the Geology and Physiography of a Portion of Northwestern Colorado and Adjacent Parts of Utah and Wyoming, by Charles A. White, containing maps and diagrams.

English Prose: Its Elements, History, and Usage. By John Earle, Rawlinsonian Professor of Anglo-Saxon in the University of Oxford. New York: G. P. Putnam's Sons. Pp. 530. Price, $3.50.

To give a brief though incomplete characterization of this work, it may be called a book on rhetoric, but it is deeper and broader than such a description would imply. The first chapter deals with choice of expression, giving parallel lists of words of Anglo-Saxon, of French, and of classical origin, and pointing out the principles which should guide a writer in using one or another of these synonyms in a given place. Some of the higher grammatical considerations are next discussed, after which the author passes to the bearings of philology on the writing of English prose. These chapters, with a short one on "mechanical appliances"—i. e., capitals and punctuation marks—make up what the author calls the analytic portion of the treatise. The subject is next treated synthetically in five chapters. The first two of these deal with the leading characteristics of prose diction—elevation, lucidity, variety, novelty, and figure being enumerated under this head. Separate chapters are devoted to idiom and to euphony, and a discussion of style closes this portion of the volume. A brief history of English prose follows. This history is divided into three periods: the first extends from the eighth century to what the author calls the first culmination of English prose in the tenth, and the second ends in the fifteenth century. A closing chapter, entitled The Pen of a Ready Writer, is a good sample of the whole book. Under this head the author affirms that "it is not an easy matter to write English prose that is worth reading." A great number of rules, directions, and cautions are to be considered, he says; but the mind of the writer should not be burdened with a consciousness of these rules at the time of writing. Next after rudimentary grammar and the reading of good authors, philology is the preparation required for writing English. The writer should strive to gain command of the wealth of the English vocabulary. As to classical training, he takes the ground that it is excellent for some purposes, but not for forming an English style. He recommends a study of the English prose of the tenth century, and notes with approval a tendency of current writers to select their leading words from the true mother tongue. The severe drill in choosing words which is enforced by the writing of poetry is a good preparation for writing prose. The volume has an index to quotations, but no general index.

Biological Lectures delivered at the Marine Biological Laboratory of Wood's Holl. Boston: Ginn & Co. Pp. 250.

All but two of the ten lectures in this volume were delivered during the summer of 1890. They are published as a contribution to educational literature, and as a means of making known the needs and possibilities of biological work to the patrons of the laboratory and to the general public. One important purpose of this course of lectures was, as stated by Prof. C. O. Whitman in the preface, "to bring specialists into mutually helpful and stimulating relations with one another." This is necessary, he says, because as specialization advances the mutual dependence of specialists increases, and isolation in work becomes more and more unendurable. The first lecture is by Prof. Whitman, on Specialization and Organization, in the course of which he states that a national marine biological station with a strong endowment is the great desideratum of American biology The second lecture, on The Naturalist's Occupation, is also by Prof. Whitman, and the others are Some Problems of Annelid Morphology, by E. B. Wilson; The Gastræa Theory and its Successors, by J. P. McMurrich; Weismann and Maupas on the Origin of Death, by Edwin G. Gardiner; Evolution and Heredity, by Henry F. Osborn; The Relationships of the Sea-Spiders, by T. H. Morgan; On Caryokinesis, by S. Watase; The Ear of Man: its Past, Present, and Future, by Howard Ayres; The Study of Ocean Temperatures and Currents, by William Libber, Jr. The lectures are rather popular in character, and some of them are illustrated with diagrams.

Second Annual Report on the Statistics of Railways in the United States to the Interstate Commerce Commission, for the Year ending June 30, 1889. By Henry C. Adams. Washington: Government Printing-Office. Pp. 566.

The railway mileage of the United States at the date of making the report was 157,758·83 miles, of which 149,948·66 miles were covered by reports to the commission. The largest mileage is in Illinois, 9,829·48 miles, and the smallest in the District of Columbia, 30·57 miles, but the District has the most railroad to the square mile and Nevada the least. The gauges of tracks are being rapidly accommodated to two standards. The standard gauge, from four feet eight and a half inches to four feet nine inches, inclusive, is used by 1,371 roads, representing 93·3 per cent of the total mileage, and the three-foot narrow gauge by 234 companies, representing six per cent of the total mileage. This shows ninety-nine per cent of the whole as conformed to these two gauges. Of the 25,665 passenger-cars in use, 23,348 are fitted with automatic couplers and 23,546 with automatic brakes; but the freight-cars are not so well provided, so that out of a total equipment of 1,097,591 engines and cars only 80,510 are fitted with automatic couplers and 128,159 with automatic brakes. As compared with foreign railway administration, the number of men employed per mile of line is remarkably small. The record of accidents to men employed "shows in a startling manner the dangerous nature of railway employment"; and a comparison in the matter with England "is greatly to the discredit of the United States." Information is given respecting the organization of property for operation, on the relations of the roads in a system to one another, the capitalization of railway property, earnings and expenses, and the merits and defects of railway statistics. Complications introduced by construction accounts, express companies, outside freight lines and car companies, and private and corporative ownership of rolling-stock make it difficult to obtain complete statistics; but, as far as the work of the railway companies proper is concerned, a fairly satisfactory exhibit is made. The tables in the appendixes give, of detailed information for the year: Classification of railways and mileage, amount of railway capital, earnings and income, general expenditures, payments on railway capital, and summary of financial operations of operating roads.

Grammar and Language. By E. de L. Starck. Boston: W. B. Clarke & Carruth. Pp. 185. Price, $2.50.

This book is defined in the sub-title as An Attempt at the Introduction of Logic into Grammar. The attempt is intended to be applied no further than to the seven languages with which the author is acquainted, among which the three groups of the Indo-European family—the Teutonic, the Slavic, and the Romance—are represented. The author believes that he discovers a general principle underlying linguistic phenomena. Grammar has, he affirms, been studied too much from the pedagogical side of the question, while the scientific side has been left out. It has been a drawback in the study of foreign languages that each one is presented to the student disconnected from his mother tongue or any other. On the other hand, the principles of general grammar, in crowning the study of the mother tongue, ought to lay a foundation for foreign languages. It results from the investigation of the principles of classification, that as speaking is nothing but a thinking aloud, it is the man's mind and the outside world as seen by him, but not the use of words, that ought to supply us with the principles. As the same classes of words exist in the different languages, a uniformity may be supposed in the building up of the framework of the sentence. It is sought to establish this as the mere skeleton of the syntactical unit, while each language is left free as to the details of the agreement, government, and order of the words, as far as this is necessary for the manifestation of its individuality and automatism. With this point in view, the theory of the single sentence is sketched in its principal outlines, as it is exhibited by the seven languages. The forms and inflections are then considered. These investigations elicit the fact that language satisfies the requirements of objectivity and subjectivity, both in the formation of its words and in the subsequent changes of their terminations, and thus makes them fit to play their part in the sentence and give needed expression to the variety of thoughts, volitions, and emotions. Yet notwithstanding the objective and subjective world are the same for all, each language has developed different forms for certain classes of words, and other modifications out of which its individuality and idiomatism are developed. Hence there are different structures and orders of words, and these are the subject of the fourth and last chapter of the book.

New York. By Theodore Roosevelt. Longmans, Green & Co. Pp. 232, with Maps. Price, $1.25.

This volume belongs to the "Historic Towns" series. The author confesses to having been tempted to make a more voluminous history than was adapted to the place and purpose of the book, but he has kept within bounds, and has made a presentment which is brief and altogether attractive. It has been his aim, less to collect new facts than to draw from the storehouse of facts already collected "those which were of real importance in New York history, and to show their true meaning and their relations to one another, to sketch the workings of the town's life, social, commercial, and political, with their sharp transformations and contrasts, and to trace the causes which gradually changed a little Dutch trading hamlet into a huge American city. I have also striven to make clear the logical sequence and continuity of these events; to outline the steps by which the city gradually obtained a free political life, and to give proper prominence to the remarkable and ever-recurring revolutions of the make-up of our mixed ethnic population." The author emphasizes the importance of learning to think less of the original nationality of our citizens and more of cultivating a feeling of "broad, radical, and intense Americanism"—looking to the quality of the citizenship rather than to the racial derivation of the citizen. Some of our best citizens are of foreign birth, and some of our worst are of American; and, as was the case with the last four mayors of New York, political lines can not be drawn between them that will not throw a foreigner and an American on one side and a foreigner and an American on the other. It is the man, not the nationality, that we must look to.

Hegel's Logic. By William T. Harris, LL. D. Chicago: S. C. Griggs & Co. Pp. 403. Price, $1.50.

This volume is the eighth in the series of German philosophical classics published by the house of Griggs & Co., and the third in the series representative of Hegel. The treatise of which it is a critical exposition is defined in the second title as a book on the Genesis of the Categories of the Mind. Prof. Harris's studies of this philosophy began in 1858 with Kant's Critique. But in 1883, when he had promised to prepare this volume, he found himself likely to place before the public an immature work, and to attack what he could not verify with his present insight; so he thought it proper to give himself seven years more of special preparation. His discovery in 1873 of the substantial identity of the East-Indian doctrines—that the differences of systems were superficial, and that the First Principle presupposed and even explicitly stated by the Sanskrit writers was everywhere the same; the principle of Pure Being as the negative unit of all things—revealed to him Hegel's deep discernment, which, in the dawn of Oriental study, had enabled him to penetrate the true essence of Hindoo thought. Hegel himself has not deduced the logical consequences of his system in the matter of the relation of Nature to the Absolute Idea; and the divergence of his system from the true Absolute Idea is explained by the author in many places. But the wrong explanation of the use of Nature does not vitiate Hegel's theory of human life and of the Christian Church. The inference of a particular species of pantheism from this defect in interpreting the Absolute Idea is regarded as a new criticism of the system of Hegel, of the truth of which Dr. Harris is confident. The interpretation given of the doctrine of reflection, the result of many years of study, is considered the key to Hegel's dialectic, "if anything may be called a 'key' to it"; and the attention of students is called to it in the hope "that a new and fruitful road to Hegel's deeper thoughts may be opened by studying that portion of the Logic which expounds the relation of 'determining reflection' to 'external reflection.'"

A Manual of Weights and Measures, with Rules and Tables. By Oscar Oldberg. Third edition. Chicago: W. T. Keener. Pp. 250.

This book is intended to give complete information on the important subject indicated in its title. It contains the elements of metrology, the relations between metrological systems and arithmetical notation, a brief review of the development of weights and measures, the demands of practical medicine and pharmacy in the matter of subdivision of the units employed; the metric system, American and English weights and measures, the relations of weight to volume, specific weight, specific volume, the construction, use, and preservation of balances or scales, weights and measures, and of alcoholometers, urinometers, and other hydrometers, and extensive tables of equivalents. The laws of the United States, as far as any exist relating to weights and measures, are included. The applications of weights and measures to prescribing and dispensing, and to the construction of formulas for liquid preparations, have received attention. The rules and tables for reduction from one system to another are the most complete that we have seen. The present (the third) edition has been revised, and is believed by the author to be free from errors.

Lake Bonneville. By Grove Karl Gilbert. Monographs of the United States Geological Survey, Vol. I. Washington. Pp. 438, quarto.

One of the most famous geographical features of prehistoric America is Lake Bonneville. The bed of this great body of water, nearly equal to that of Lake Huron in extent, occupied the northwestern part of what is now the Territory of Utah. It has left several sets of clearly marked shore-lines, which have been carefully studied. The Great Salt Lake now occupies about one tenth of the ancient bed, and some smaller existing lakes were included in it. The time of Lake Bonneville was the Quaternary era, or, as the present author prefers to call it, the Pleistocene period. One of the first large works begun by the Geological Survey, under the directorship of Clarence King, was an investigation of the Pleistocene lakes. A volume was to be devoted to the description of Lake Bonneville, and all general discussions were to be deferred until many lakes had been studied. The extension of the field of the survey over the whole United States led to the abandonment of this undertaking, and hence such generalizations as were permitted by the material gathered have been included in the present volume. After an introductory chapter the author takes up the general topographic features of lake shores, pointing out those formed by waves, shore currents, and inflowing streams, and describing the character of an adolescent and of a mature coast. He then applies these principles to the shores of Lake Bonneville. The Bonneville shore-line proper is about 1,000 feet above Great Salt Lake; 375 feet lower is a strongly marked shore-line, called the Provo, made after the lake had shrunken considerably from its greatest extent, and between these two elevations are intermediate shore-lines due to fluctuations of the water surface before the greatest extent was reached. An account is then given of the outlet formed at the north end of Lake Bonneville, where 375 feet of alluvium was quickly cut through, lowering the water to the Provo level. A chapter is devoted to the lake sediments found within the Bonneville shore-line, after which a connected history of the Bonneville basin is given, and a parallel is drawn between this and the history of Lake Lahontan. The relation of volcanic eruption to the lake history is treated separately, as is also the effect of movements of the earth's crust in deforming the shore-lines. The volume ends with a discussion of the Equus fauna, which is not found within the limits of Lake Bonneville, but which is connected with the lacustrine history introduced into an earlier chapter. There is an appendix on Altitudes and their Determination, by Albert L. Webster, and two on geodetic problems connected with the ancient lake, by R. S. Woodward. The volume is liberally illustrated with full-page, double-page, and many smaller views, maps, diagrams, etc., many of the maps being colored, and there is a folded map of the lake, about three feet by two, which is also printed in colors.

A Historical Geography of the British Colonies. By C. P. Lucas. Vol. II. Oxford, England: Clarendon Press; New York: Macmillan & Co. Pp. 343. Price, $1.90.

Predominant importance is given in this book to the American colonies, in which British colonization began, and which are the most extensive; and they are historically, statistically, and comparatively presented in tables and diagrams. A distinction is drawn between the North American and the West Indian colonies, while the Bermudas and the Falkland Islands lie outside of both. The North American colonies, though they include islands, are continental; while the West Indian, though they extend to the continent, are, on the whole, a collection of island dependencies. In Canada and Newfoundland the drawbacks to colonization have been ice and snow; in the West Indies they have been tropical heat and hurricanes. In the Northern colonies nearly all the inhabitants are of European origin; in the West Indies blacks predominate. There are other historical as well as racial distinctions, but one point the two groups have in common: "They are settlements, and not mere dependencies. The heat of the West Indies has not prevented the British race from colonizing the islands, and, though the negro race has long been greatly superior in numbers to the white, the history of an island like Barbados shows that even in the tropics the connection between Great Britain and America has been that of permanent settlement rather than of passing trade or foreign rule." The Bermudas, the West Indian colonies, those of the South American coast, the Falkland Islands, and South Georgia are described, historically and geographically, and the descriptions are illustrated by good though small maps.

The relative merits of the incandescent electrical light and some other lights that are suggested are discussed by Prof. *E. L. Nichols*, of Cornell University, on *The Artificial Light of the Future.* The author finds that there are limitations to the life and usefulness of the incandescent light and of the arc light that are not likely to be overcome. Inquiring for a better light, he finds that of magnesium superior in quality and efficiency to any other as yet known. It affords, weight for weight, thirty times the light obtained from gas, with the development of much less heat, and gives the nearest approach to sunlight in whiteness; while in illuminating power each unit of it must be regarded as the equivalent of rather more than 1·25 units of gaslight. It has a quality believed to be the same as that named by Prof. Wiedemann *luminescence*, an effect, akin to phosphorescence, fluorescence, etc., of a different class of molecular vibrations from those which cause incandescence, to which importance is attached, enabling it to radiate light without heat. A similar quality belongs to the oxide of zinc, the properties of which as an illuminating substance are also studied.

From *Wm. Paul Gerhard*, consulting engineer for sanitary works, three monograph pamphlets are received, the nature and value of which are indicated by their titles. They are *Architecture and Sanitation*, in which the advantages of employing a sanitary engineer for building-work related to his sphere are insisted upon; *Notes on Gas-lighting and Gas-fitting*, which abounds in practical suggestions; and the *Disposal of Sewage of Isolated Country Houses*, a matter that is too often neglected or ignorantly attended to.

A paper on *Faith-Healing in the Sixteenth and Seventeenth Centuries*, read before the American Folk-lore Society by *Charles F. Cox*, is intended to draw a parallel between the superstitious modes of cure and practices of the period named and the faith-cures, etc., of the present, and to show that the latter are what are called, in the theory of evolution, survivals. Illustrations are drawn from the career of Paracelsus, the weapon-salve of Robert Fludd, and the sympathetic powder of Sir Kenelm Digby. The influence of suggestion is supposed to have played a considerable part in such success as the charlatans practicing these cures may have had. The author avows the belief that cures have been, and are nowadays, effected by the methods employed by the different species of faith-healers, and explains them on the theories expounded by Dr. W. B. Carpenter, or as cases of hypnotism.

The *Rules and the Application of Reichert's Hæmometer*, an instrument designed to ascertain the amount of hæmoglobin in either a diseased or a normal condition of the blood, are described by *Frederick Gaertner*, M. D., in a paper which was read before the iron City Microscopical Society, Pittsburg.

Vol. XXIII of Annals of the Astronomical Observatory of Harvard College, of which Part I is published, is devoted to the *Discussion of Observations made with the Meridian Photometer during the Years 1882–1888*, by *Edward C. Pickering* and *Oliver C. Wendell.* The first parts of the investigation of which the continuation is recorded have appeared in a previous volume, and a third volume will be required to contain the whole. A larger instrument than those with which the earlier observations were made, but like it, was applied in the present series to fainter stars. The observations relate principally to stars north of declination −40°. The work having been done at Cambridge, the instrument has been sent to Peru, for observation of the Southern stars. The details of this series will be published in another volume. A careful description is given of the instrument and the method of using it.

In *Consumption and Liquids* a theory of the prophylaxis and cure of consumption by suralimentation of liquid food is presented by *W. H. Burt*, M. D., of Chicago. The author believes that his remedy is not only the greatest of known prophylactics, but that it will arrest and cure pulmonary consumption; that, when used in the first and second stages of phthisis, it will enable the physician to cure more than fifty per cent of the patients that would have to die with the best methods known to medical science up to the present date; but, in the third or last stage, it will give only temporary relief. It should, however, always be combined with the best remedies known to medical science; and, with this in view, the author has added most of the practical remedies in medical literature, together with all the auxiliaries at the command of the physician. Hence his book contains chapters on the etiology and prophylaxis of the disease, the part that water occupies in the human body and its therapeutic value, fruit, and specific remedies. W. T. Keener, publisher, Chicago.

The Geological Survey of Missouri, Arthur Winslow, State Geologist, publishes in Bulletin No. 2 *A Bibliography of the Geology of Missouri*, compiled by F. A. Samson. The author has adopted a system of classification of books and papers into those which are products of individual investigation—with entire or with partial reference to Missouri; compilations from publications of original investigation; and incidental or dependent publications. To the first class belong reports of geological surveys, of the State Board of Internal Improvements, the Bureau of Statistics, the Smithsonian Institution, university and agricultural reports, etc., 472 titles; to the second class, compilations from those made for different offices and institutions and for various purposes, 162 titles; and to the third class, occurring in many ways and places, 167 titles. Of the publications of the State of Missouri there are 144 titles; of the United States Government, 65 titles; of other State surveys, 13 titles; and of miscellaneous publications, 579 titles. The dates of publication of these papers, by decades, show a regularly increasing interest in the subject. Bulletin No. 3 of the same office contains papers on the *Clay, Stone, Lime, and Sand Industries of St. Louis City and County*, by *G. E. Ladd*; and *The Min-*

eral Waters of Henry, St. Clair, Johnson, and Benton Counties, by *A. E. Woodward*.

The sixteen-page monthly journal, formerly called *The Naturalist*, now comes as *The Kansas City Scientist*, and as the organ of the Kansas City Academy of Sciences, with *R. B. Trouslot* as chief editor. It is filled with original papers, which in the present number (January, 1891) relate to owls—those of Chester County, Pa., and those of eastern Iowa—geological observations in Colorado; the movements of animals; and other matters of personal observation. Price, $1 a year.

The first of a series of three volumes under the general title Epochs of American History, has been published (Longmans, $1.25). This volume deals with *The Colonies: 1492 to 1750*, and the author is *Reuben G. Thwaites*, Secretary of the State Historical Society of Wisconsin. The editor of the series, Dr. A. B. Hart, of Harvard College, states that the purpose of these books is to "show the main causes for the foundation of the colonies, for the formation of the Union, and for the triumph of that Union over disintegrating tendencies. To make clear the development of ideas and institutions from epoch to epoch." Hence no attempt is made to include all the facts that would belong in a complete record. To aid readers who may wish to go into the details of narrative and social history, each chapter throughout the series is to be provided with a bibliography. Historical geography will receive especial attention. The present volume contains four maps, one showing the physical features of the United States, the other three showing how the country was divided among England, France, Spain, etc., at different periods. The author of the first volume, in mentioning some of the topics he has treated, says: "The social and economic condition of the people is described, and attention is paid to the political characteristics of the several colonies, both in the conduct of their local affairs and in their relations with each other and the mother-country. . . . Attention is called to the fact, generally overlooked, that the thirteen mainland colonies which revolted in 1776 were not all of the English colonial establishments in America; a chapter is devoted to a description of the several outlying sister colonies, showing wherein they differed from the thirteen, and why they did not join in the revolt." The matter of the volume is conveniently arranged, and is fully indexed.

Recognizing the interest which students of American history and politics must take in the study of federal government as being in effect a study of the principles underlying their own institutions, Prof. *Albert Bushnell Hart* has prepared for the series of Harvard Historical Monographs (Ginn & Co.) an *Introduction to the Study of Federal Government*. The development of the federal system is noticed as having been one of the most striking political tendencies of the last century, and has been exemplified on a considerable scale in Switzerland, Germany, England and its colonies and dependencies, Canada, the South American states, and, pre-eminently, the United States. The present monograph gives, in its first part, an outline of the political history of the several confederations, beginning with the ancient Grecian and Italian leagues and closing with those of Latin America; and in the second part a parallel view of the four leading federal constitutions now in operation, in which each constitution is made to serve as a practical commentary on the others. In a chapter on The Theory of Federal Government, the doctrine of sovereignty is defined, certain new federal combinations of states are described, the nature of federal government is analyzed, federal governments are classified, and their political conditions are considered.

The French Invasion of Ireland in '98, an episode of the French Revolution that has heretofore received little attention, has been made the subject of a volume by *Valerian Gribayédoff* (C. P. Somerby, New York, $1.50). The story is told in a popular way, and is attractively illustrated. The pictures include battle-scenes and portraits, most of the latter being drawn by the author. The record is substantiated by frequent reference to contemporary accounts, and the appendix contains several letters bearing on the events of the campaign.

Political Americanisms (Longmans) is a convenient and useful glossary of terms and phrases current at different periods in American politics, by *Charles Ledyard Nor-*

ton. "It is impossible," the compiler remarks, "to look over the columns of a daily journal, especially during the progress of a spirited political campaign, without encountering numerous expressions and phrases, the meaning of which can not be learned from any dictionary, but which, to one who is familiar with the current *argot* of the period, are often quite as vigorously expressive as the most picturesque slang of the street." Mr. Norton's attempt is to explain most of these expressions. Without claiming to be exhaustive, he has included a number of phrases which, he says, can be found in no other compilation. Some have passed out of current use, others are still living. The definitions are studiously uncolored.

Prof. *J. Howard Gore*, in a paper on *The Decimal System of Measures of the Seventeenth Century*, presents the claims of the priest, Gabriel Mouton, of Lyons, to be regarded as the originator of the decimal system. As early as 1665 he proposed a scheme of measures by tens, the unit of which was derived from a minute of the arc of the terrestrial great circle, and which embodied the essential features of the scale proposed by the official commission in 1799.

W. M. Griswold, the industrious index-maker, has prepared and publishes, at Cambridge, Mass., in a pamphlet of fifty-two pages, *A Descriptive List of Novels and Tales dealing with American Country Life*. Its purpose is to direct readers, having a taste for books of the kind, to a number of novels, easily obtainable, but which may have become forgotten in the rush of other novels coming after them. Many of these books are typical, or have a historical value; some of them are of the first quality of excellence, and should not be allowed to perish at least in the present age; and all are worthy of the place given them. Descriptive notices are appended to each of the titles, which have usually been selected from reviews in the standard critical journals. Other lists of kindred character are promised.

The Indiana *College Association* was formed in 1878 for the mutual improvement of its members and the consideration of college instruction and management, and now includes representatives of fourteen institutions. It has held meetings every year, but no publications were made of the proceedings of its meetings from 1884 to 1888. The full publication of the *Proceedings and Addresses* of the thirteenth session, December, 1890, is accompanied by abstracts of the proceedings of these five sessions. The principal addresses at the meeting of 1889 were on The Religious Sentiment in its Relation to Scholarship, President J. J. Mills; Relations of Mathematics to Metaphysics, Prof. A. S. Hunter; The Function of the Laboratory in Technical Schools, Prof. Thomas Gray; The Study of Man through Language and Literature, Prof. Hoffman; Word Color, Prof. E. B. T. Spencer; and Mathematics in the Preparatory Schools, Prof. R. J. Aley.

A strange volume is that entitled *A Secret Institution*, written by *Clarissa C. Lathrop* (Bryant Publishing Co.), to describe the events that led to her incarceration in the Utica Insane Asylum from 1880 to 1882, her treatment there, and the way she obtained her release. Its purpose is to call attention to the injustice which many persons have suffered through being committed to asylums and kept there when perfectly sane. The writer draws a dark picture of asylum life, and her story shows what terrible abuses are possible where the light of investigation can not penetrate.

A novel in which a representation of one of the current forms of socialism is given has been written by *Albion W. Tourgee*, under the title *Murvale Eastman, Christian Socialist* (Fords, $1.50). The social doctrines are applied in the dealings of a street railway company with its employés. The story is more than a mere vehicle for the doctrines, being rich in plot and incident.

A number of geological monographs of much interest have recently been published by Prof. *Warren Upham*. First on the list in the amount of labor it represents is the author's *Report of Exploration of the Glacial Lake Agassiz in Manitoba*, which appears in connection with the report of the geological survey of Canada. Lake Agassiz was a lake, the result of the damming of the waters by ice in glacial times, which existed in the Red River Valley in Dakota and Minnesota, and thence toward the north across Manitoba into Saskatchewan, covering an area (about 110,000 square miles) greater than that of the five Laurentian lakes combined. Prof. Upham having studied the remains of this lake as defined by its ancient beaches in the United States, obtained authority from the Canadian survey to carry on his investigations in the British territory, and his paper of one hundred and fifty-six pages furnishes the evidence that he did so very carefully. The paper is illustrated by a map of the country of Lake Agassiz, showing its position and probable extent and its relation to the Upper Laurentian lakes, and by a map of its beaches and deltas in southern Manitoba. Many artesian wells have been obtained in the plain which occupies the site of the valley of the ancient lake, and the description of these furnishes the substance of a paper on *Artesian Wells in North and South Dakota*. Prof. Upham is not confident that the wells can be made efficient in these regions for irrigation. A well flowing one hundred gallons a minute would be needed to irrigate a quarter section, or one hundred and sixty acres of land—the usual area of a homestead. Such a well would cost seven thousand dollars, and to this the outlay for reservoirs and conduits would have to be added. *A Discussion of the Climatic Conditions of the Glacial Period* was participated in, in the Boston Society of Natural History, by Frank Leverett, Prof. Shaler, and Prof. W. O. Crosby, with Prof. Upham. Prof. Upham thought the conditions most favorable to the formation of the ice-sheets were long-continued rather than excessive cold, with an abundant supply of moisture by storms, and cooler summers than now. In a fifth paper the *Fiords and Great Lake Basins of North America* are considered as evidence of pre-glacial continental elevation and of depression during the Glacial period.

PUBLICATIONS RECEIVED.

Agricultural Colleges and Experiment Stations, Reports and Bulletins.—Cornell University. Third Annual Report. Pp. 54.—University of Illinois. Bulletins Nos. 13, 14, and 15 (Corn, Milk, and the Fruit-bark Beetle). Pp. 64, 16, and 28.—Kansas Agricultural College. Second Annual Report. Pp. 150.—Massachusetts Agricultural College. Twenty-eighth Annual Report. Pp. 69.—Michigan (Vegetables). Pp. 41.—New Jersey (Fertilizers). Pp. 24.—Utah Agricultural College. First Annual Report. Pp. 32.

Agriculture, Department of, Washington. The Work of the Agricultural Experiment Stations. Pp. 16.

Amateur Electrician. Monthly. Ravenswood, Ill. Pp. 26. $1 a year.

Bandelier, A. F. Contributions to the History of the Southwestern Portion of the United States. Cambridge, Mass.: Archæological Institute of America. Pp. 206, with Map.

Barrows, Henry D. International Bimetallism. Los Angeles, Cal.: Stoll & Thayer. Pp. 55.

Billings, John S., M. D. Public Health and Municipal Government. Philadelphia: American Academy of Political and Social Science. Pp. 23.

Brown, George P. Religious Instruction in State Schools. Bloomington, Ill. Pp 8.

Brown, Thomas J. Civilian Directorship of the New Weather Bureau.

California State Mining Bureau. Preliminary Mineralogical and Geological Map of the State of California. 4 sheets.

Carus, Paul. The Soul of Man. Chicago: Open Court Publishing Co. Pp. 458. $3.

Coast and Geodetic Survey, United States. Report on Oyster Culture in Georgia. By Ensign J. C. Drake. Pp. 30, with Maps.—Determination of an Azimuth. By A. T. Musman. Pp. 4.—Bering's Magnetic Observations. By C. A. Schott. Pp. 4

Comstock, Theodore B. Geology of the Central Mineral Region of Texas. Austin. Pp. 154.

Cotterill, J. H., and Slade, J. H. Lessons in Applied Mechanics. Macmillan & Co. Pp. 517. $1.25.

Crothers, T. D. Relation of Life Insurance to Inebriety. Pp. 2.

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Crooker, J. H. Different Views of Jesus Boston: American Unitarian Association. Pp. 80.

Dawson, George M. Geological Structure of the Selkirk Range. Rochester: Geological Society of America. Pp. 8.

Eggleston, G. C., and Marbourg, Dolores. Juggernaut. Fords, Howard & Hulbert. Pp. 343. $1.25.

Fewkes, J. Walter. Passamaquoddy Folk Lore. Pp. 27, with Plate. Cambridge, Mass.: Archæological Institute of America.

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Iowa State Medical Society. Transactions, 1890. Cedar Rapids. Pp. 307.

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Larison, C. W., M. D., Ringos, N. J. The Journal of Health. Monthly. Pp. 16. $1 a year.

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Miller, C. G., Chihuahua. A Social Drama. Chicago: Kehm, Fetsch & Wilson Co. Pp. 96. $1.

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Parker, William W., M. D., Richmond, Va. The Rise and Decline of Homœopathy. Pp. 12.—Burial *vs.* Cremation. Pp. 8.

Peterson, Frederick, M. D. Anodal Diffusion as a Therapeutic Agent. Pp. 11.

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Rosse, Irving C., Washington. Clinical Evidences of Border-land Insanity. Pp. 16.

Salmon, David. Longmans' Primary School Grammar. Longmans. Pp. 124. 35 cents.

Sanborn, J. W. Missouri Experiment Station. Synopsis of Experiments. Pp. 40.

Shoup, Francis A. Mechanism and Personality. Ginn & Co. Pp. 343. $1.30.

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Woolsey, W. J., St. Paul, Minn. Prophetic Evolution. Pp. 16.

POPULAR MISCELLANY.

Our Sequoia Forests.—Counting as forests all areas of a thousand acres and upward, Mr. Frank J. Walker computes that there are now 37,200 acres of Sequoia forest in the United States, divided as follows: King's River forest, 7,500 acres; Kaweah River, 14,000; Tule River, 14,000; Kern River, 1,700 acres. They are all south of King's River, and nearly all of them in Tulare County, Cal., and extend over a belt of country beginning at Converse Basin on the north, and ending with the Indian Reservation forest. The groves and forests within this region are more than twenty in number, with an average distance between them of perhaps three or four miles. The southern limit of the Sequoia is the Deer Creek Grove, which contains less than one hundred and fifty Sequoias, scattered over an area of perhaps three hundred acres. Too many of these noble woods have already passed into the hands of speculators, and are doomed shortly to disappear. One tract, including two townships, has lately been saved to the public by the Vandever Bill. It embraces the Sequoia Park forest and most of the Homer Peak forest, and contains what are known as the Fresno Big Trees—among them the General Grant, which is said to be forty feet in diameter. Besides its value for the storage of waters needed for irrigation, this whole region has charming natural attractions that make it most eminently suitable for a park, of which Mr. Walker says: "The height of the Sierra, culminating in Mount Whitney, affords grand scenery of peculiar charm and great variety. Here are three Yosemites rivaling their noted prototype in many features, with a little world of wonders clustering around the head-waters of Kern, Kaweah, and King's Rivers. We will simply mention the Grand Cañon of the Kern, where, for twenty miles, the mad waters of the river are walled in with the continuous battlements of the California Alps, crowned with nameless and unnumbered domes and towers. Then, only a few miles across the divide, extends the cañon of King's River, with its wealth of impressive scenery; and some eight miles farther to the north lies the Valley of Tehipitee—the gem of the Sierra—with its wondrous dome of rock rising in rounded majesty some six thousand feet from the level of the river-cleft meadow at its feet. A view of the most impressive and characteristic scenery of the region is to be earned by scaling one of the lofty peaks of the Kaweah range. At least a hundred peaks here rise to altitudes exceeding ten thousand feet. . . . Here, standing on the crest of the Kaweah Sierra, one looks across the Grand Cañon of the Kern, and the encircling wilderness of crags and peaks is beyond the power of pen to describe. Mounts Moriache, Whitney, Williamson, Tyndall, Kaweah, and a hundred nameless peaks—the crown of our country—have pierced the mantle of green that clothes the cañons below, and are piled into the very sky, jagged and bald, and bleak and hoary—a wilderness of eternal desolation."

The Custom of Potlatch.—One of the most complicated and interesting institutions of the Northwestern Indian tribes of Canada, according to Mr. Horatio Hale's report on the subject to the British Association, is what is called *potlatch*—the custom of paying debts and of acquiring distinction by means of giving a great feast and making presents to all the guests. It is somewhat difficult to understand the meaning of the *potlatch*. The author would compare its most simple form to our custom of invitation or making presents, and the obligations arising from the offering, not from the acceptance, of such invitations and presents. Indeed, the system is almost exactly analogous, with the sole exception that the Indian is more anxious to outdo the first giver than the civilized European, who, however, has the same tendency, and that what is custom with us is law to the Indian. Thus by continued *potlatches* each man becomes necessarily the debtor of the other. According to Indian ideas, any moral or material harm done to a man can be made good by an adequate *potlatch*. Thus, if a man is ridiculed by another, he gives away a number of blankets to his friends, and so regains his former standing. I remember, for instance, that the grandson of a chief in Hope Island, by unskillful management of his little canoe, was upset near the beach and had to wade ashore. The grandfather felt ashamed on account of the boy's accident, and gave away blankets to take away the occasion of remarks on this subject. In the same way a man who feels injured by another will destroy a certain amount of property; then his adversary is compelled to do the same, else a stain of dishonor would rest upon him. This custom may be compared to a case where a member of civilized society gives away for no good purpose a considerable amount of money ostentatiously in order to show his superiority over a detested neighbor. A remarkable feature of the *potlatch* is the custom of giving feasts going beyond the host's means. The procedure on such occasions is also exactly regulated. The foundation of this custom is the solidarity of the individual and the *gens*, or even the tribe, to which he belongs. If an individual gains social distinction, his *gens* participates in it. If he loses in respect, the stain rests also on the *gens*. Therefore the *gens* contributes to the payments to be made at a festival. If the feast is given to foreign tribes, the whole tribe contributes to these payments. The man who intends to give the *potlatch* first borrows as many blankets as he needs from both his friends and from those whom he is going to invite to the feast. Every one lends him as many as he can afford, or according to his rank. At the feast these are given away, each man receiving the more the higher his rank is. All those who have received anything at the *potlatch* have to repay the double amount at a later day, and this is used to repay those who lent blankets. At each such feast the man who gives it acquires a new and more honorable name. In one tribe the chief's son, some time after his father's death, adopts the latter's name. For this purpose he invites all the neighboring tribes to a *potlatch*. During the festival he stands on the permanent scaffold in front of his house, assisted by two slaves, who distribute the presents among the guests sitting or standing in the street. As it is necessary to give a great festival at the assumption of the chief's name, the new chief continues sometimes for years and years to accumulate wealth for the purpose of celebrating this event.

Persistence of Life.—The distinctions between plant and animal, pointed out by Prof. Dana, in the introduction to his Manual of Geology, have reference to the absorption by the plant of carbonic acid and by the animal of oxygen; of manufacturing organic food for the animal by the plant from inorganic materials, etc.—matters which Prof. Persifor Frazer does not regard as concerning the question of the essential continuity of inorganic with organic force, and the separation of the phenomena of the latter from those of the former by an indefinable line. No hard-and-fast line, in Prof. Frazer's view, can be drawn to separate animal from plant, and none to separate plant from crystal. The force which is the cause of production and of change seems as if it were simply modified to suit the various structures which it builds. The material in all three kingdoms of nature is the same. Having reviewed the modes of growth in the three kingdoms, the author concludes that there are strong analogies between them, the divergence being progressive as we go from mineral to plant and from plant to animal. Common characteristics of the three kingdoms are the presence of force, its action upon matter, and its renewal by the change of one form of matter to another, in the course of which energy is manifested. In the crystal kingdom the restrictions on the existence and growth of the individual being least, and the variations of conditions and environment in which existence is possible greatest, the individuals are more numerous and their composition more diverse. The cycles of changes in the plant and animal kingdom are based for the most part upon the disunion and separate combinations of carbon and hydrogen, because under existing conditions of temperature, etc., these changes can be produced to the greatest advantage of existing kinds of living things and life forces. With a much hotter or colder earth, when the weights of bodies were much greater or less than they are now, not surrounded by an ocean of oxygen gas, or deprived of the chemical force of our sun, some changes would be made in the modes in which life is perpetuated to suit the changed conditions of the planet; "but it is extremely unlikely that life would be extinguished by them unless the conditions changed too suddenly." These changes might affect the kind of matter flowing through the living body, or the attributes of the living thing; or, "if both the elements themselves and the rapidity with which they resolved themselves into new combinations were changed, the diversity of the living things and of the world itself would be so different from what they are now that we have no means of forming the least conception of them. But in none of these cases is it likely that life would become extinct, though the present relations to each other of the three kingdoms of nature would cease to be."

Adulterants as Diluents.—People, as a rule, suppose that any substance used as an adulterant of a food-product, or as a substitute for it, is to be avoided as injurious to health. This, according to Mr. Edgar Richards, is not quite correct It is, in fact, contrary to a manufacturer's interest to use any substance that would cause injurious symptoms, for it would be detrimental to his business. The majority of substances used for food adulterants or substitutes are cheap and harmless, and do mischief only as they go to dilute the genuine article. The principal adulterant of milk is water; and the great harm of it appears when it is fed to a child or an invalid, who might be starved to death if compelled to rely on watered milk for his sole sustenance. The skill of the milk adulterator has kept pace with the march of improvement; and a centrifugal machine is in the market for manufacturing an artificial cream or milk from skimmed milk and also oil, the strength of which depends on the amount of animal fat added. This, it is said, can be used for all purposes for which genuine milk is employed. Oleomargarine and refined or compound lard are made from what were formerly considered waste products of slaughter-houses. When properly made, with due attention to cleanliness, they furnish a palatable and wholesome product, "which is, however, not intended to compete with 'gilt-edge' butter." Mr. Richards, in fact, prefers compound lard to "prime steam lard," which he characterizes as "about as disgusting a mixture as can be imagined." Cotton-seed oil is used in the manufacture of compound lard, and in the place of olive oil for the table, and in medicinal preparations. The wholesome qualities and purity and uniformity of composition of glucose, or sugar manufactured from starch, have been reported on favorably by a committee of the National Academy of Sciences. However much the public may be cheated in the purchase of ground spices, coffee, etc., adulterated with flours and starches, people are not poisoned by their consumption; and "it is a question how much a purchaser is himself to blame in his endeavor to secure a 'bargain' when he demands a quantity of any given material at less than it can be purchased at wholesale in the market." The addition of antiseptics to food in order to preserve it in transportation is often deleterious and can not be considered safe.

Extraordinary Memories.—Among the recorded instances of marvelous memory is one given by Archdeacon Fearon of a person in his father's parish who could remember clearly all the burials, with the exact dates and all the details, which had taken place there for thirty-five years, but in all other respects was a complete fool. George Watson, according to Hone's Every-day Book, could remember, with like exactness, every event of every day from an early period of his life. Another similar case is that of Daniel McCartney, related in the Journal of Speculative Philosophy. Memory Corner Thompson was able to draw, upon order, exact and perfect plans of many of the parishes of London, with everything in its place and nothing left out. On the side of the learned, Scaliger read nothing which he could not remember, and committed Homer to memory in twenty-one days, and all the Greek poets in three months. Like powers, changing only the authors learned, were displayed by Bishop Saunderson, Euler, Leibnitz, Gilbert Wakefield, and Porson. The same power is called into action in the acquisition of languages; and here we have the instances of Crassus, who could try cases and pronounce judgments in any of the dialects of his Asiatic prætorate; Mithridates, who administered the laws in all the languages of the twenty-two nations of his empire; Sir William Jones, who knew thirteen languages well, and could read with comparative ease in thirty others; John Leyden, who had a good acquaintance with fifteen languages; George Borrow, who translated prose and poetry from thirty languages; Edward Henry Palmer, who could speak the native tongue of every European nation, and was so perfect a master of Arabic, Persian, Hindustani, Turkish, and the language of the gypsies, that even natives were sometimes deceived as to his nationality; Viscount Strangford and Elihu Burritt, "the learned blacksmith"; Cardinal Mezzofanti, who professed to be able to speak in "only fifty-two" languages; Sir John Bowring, who was much like him in gifts; and Von der Gabelentz, who "seems to have been equally at home with the Suahelis, the Samoyeds, the Hazaras, the Aimaks, the Dyaks, the Dakotas, and the Kiriris; who could translate from Chinese into Manchu, compile a grammar or correct the speech of the inhabitants of the Fiji Islands, New Hebrides, Loyalty Islands, or New Caledonia."

Mobility of Labor.—Discussing in the British Association the effects on mobility of labor of the introduction of machinery and the tendency to production on a large scale, Mr. H. Llewellen Smith defined mobility as the free economic device of employment, by change either of occupation or of place. It is not the same as movement, nor is the one measured by the other. It is measured by the extent to which a set of workers engaged in a particular process, or in making a particular article, would or would not suffer economically by a change in the demand for that process or that article. There is, besides, "initial mobility," or the free effective choice of occupation at the outset. This is effected by the localization of industries and the tendency to heredity, which again is strongest in domestic trades and weakest in factories. The general result reached by discussion is, that modern changes tend to divide up a process of manufacture into a number of detail processes of which one man performs only one, but the various members of the group of workers producing a particular article become less and less specialized with regard to that article, and their range of mobility, which is narrowed as regards power of interchange among themselves, is widened as regards power of interchange with workers engaged in corresponding processes of other trades. Machinery often tends to facilitate this interchange by transferring different manufactures into different groupings of nearly identical detail process. Hence, while dividing up employments on the one hand, machinery reintegrates them on fresh lines. Thus the boundaries of trades and industries are shifting and industries are regrouping themselves. Apprenticeship and trade customs are affected. There is a simultaneous tendency to shorten the time necessary to learn a particular process, and so to increase the ease (though not always the practical opportunity) of interchange among different processes of the same trade.

Rubies and Sapphires in Siam.—The gem-mines of Siam are at Krung, Krat, and Phailin, points or districts dependent on the seaport of Chantabun. They are shortly to be leased; but at present the only condition required for entering the mines is the payment of a small fee to the head man of the district. The digger's first object is to discover a layer of soft, yellowish sand, in which both rubies and sapphires are deposited. This stratum lies at depths varying from a few inches to twenty feet, on a bed of subsoil in which no precious stones are found. A pit is dug, and the soil removed is taken to a neighboring canal or stream, where it is mixed with water and passed through an ordinary hand-sieve. In his search for this peculiar alluvial deposit, which is generally free from any admixture of clayey earth, the digger has often to penetrate into the jungle that grows thickly around, and combines the work of clearing with the occupation of gem-digger. No sapphire has yet been extracted of higher value than about fourteen hundred dollars, or ruby of higher price than forty-eight hundred dollars. No artificial or mechanical processes for washing the soil have so far been introduced. Rubies and sapphires are found at all the diggings, often deposited side by side, in the same layer or stratum of sand. The rubies are usually of a dull, light-red hue. The sapphire is of a dark, dull blue, without any of the silken gloss distinctive of the Burmah and Ceylon stones. Stones resembling garnets rather than rubies are found in the dried beds of water-courses at Raheng, two hundred miles north of Bangkok, and there is every reason to believe that rubies, also, at least equal to those discovered in the southeast, exist throughout the Raheng district.

What may be learned from a Spinning Top.—The earth as a spinning top was substantially the subject of an "Operatives' Lecture," by Prof. John Perry, at the British Association. The lecturer's purpose was to exhibit the analogies between the motions of tops and the rotation of the earth, and show how many phenomena can be explained by them. He said that, if more attention was paid to the spinning of tops, much greater advances would be made in mechanical engineering and industrial invention; geologists would not make so many mistakes of millions of years in their calculations; and we should all have a much better knowledge of astronomy, of light, of magnetism, and of electro-magnetic subjects. First the lecturer illustrated the *quasi*-rigidity that rapid rotation gives to a flexible or fluid body. A thin sheet of paper assumed the stiffness of a board. A chain released from a hub rolled like a solid wheel. A fly-wheel being made to revolve rapidly when inclosed in a brass box, the box did not tumble down, but maintained a vertical position and offered resistance to any attempt to turn it round. If it was tilted, it turned with a precessional motion. Every spinning body, the lecturer said, resists a change of direction of its spinning axis. Rotating machines on board ship offer greater resistance to pitching and rolling. A top thrown up would fall down anyhow; but if it was thrown up spinning, there would be no doubt as to the position it would come down in, because the spinning axis always keeps parallel with itself. The fall of a biscuit or a hat is equally controlled by throwing either with a spinning motion. For this reason the barrels of guns are rifled; and the same principle explains the feats of jugglers with hats, hoops, plates, umbrellas, and knives. All that appears incomprehensible in the curious motions of the gyrostat under various conditions loses its mystery when the motions are regarded as rotation about various axes; and herein is found the key to the phenomenon of precession. The application of these principles to the motion of the earth was illustrated by diagrams and by the wabbling motion communicated by the hand to objects with three axes, which, spun first on the shortest axis, would of themselves rise to spin on the longest axis. A circular chain hanging vertically from a cord, when made to revolve rapidly, first wabbled and at last became a horizontal ring. In dealing with the question whether the earth is a shell filled with fluid, the professor gave a vibratory motion to vessels containing respectively sand, treacle, oil, and water. A boiled egg had a slower oscillation than an unboiled one. When the two eggs were rolled, the unboiled one stopped sooner than the boiled one. The liquid inside went on moving and renewed the motion of the shell after it had been stopped by the finger. It is easy to spin a boiled egg, but not an unboiled one.

Sheep-raising in Algeria. — Sheep-raising is the principal business of the Algerian Arabs of the high plateaus. Neither the sheep nor the wool are of the first quality, but the sheep can resist a great variety of hardships to which they are subjected in the not very pleasant region they live in. As they require to be watered every two or three days in summer, they can not be taken for pasturage to regions far removed from a supply. They are not at all particular about the quality of what they drink, but water of some kind they must have; and no use can be made of pasturage beyond a reasonable distance from springs. This area is therefore eaten down to the ground, while succulent pasturage beyond it goes to waste. Hardly more than one fifth of the extent of the high plateau, for this reason, is available. Algerian wool is Arab or Berber. Arab wool is generally of a short fiber, sometimes moderately, rarely very long, and regulated as to length by the climatic influences of the localities where the sheep are raised. It is always short on the high plateaus, and becomes longer as the sheep descend into more fertile and better watered regions; but in both instances it is pure wool, of a fine quality, and without any hairy appearance. Berber wool is hard and coarse, and is confined to mountainous and sometimes inaccessible regions, where there is constant pasturage, and the migration of flocks in the summer season is unnecessary.

Care of our Eyes.—Few persons are aware, says M. Félix Hément, that besides size, shape, and color, their eyes differ in visual force and in power of accommodation; and also that some faults affect only one of them. It is an established fact that we all use one eye—the right or the left—in preference, when looking through a glass or taking aim with a gun. We are right- or left-eyed as we are right- or left-handed or footed. If we do not perceive this ourselves, oculists and opticians remark it. The ignorance of most people on this subject is illustrated by their buying glasses at the opticians without taking account of any difference between the eyes. Thus only one of the eyes is helped, while the other one, being less called into exercise, becomes less and less useful, and loses its powers as a tool rusts when it is not in use. Yet both our eyes are needed to see well. It becomes, therefore, highly important to observe how the child uses its eyes, in order to correct those attitudes which tend to injury of the sight as well as of the health. Children, in writing, rarely fail to give the head an inclination by which the eyes are placed at unequal distances from the paper. They are also apt to incline their head too far, and acquire the habit of bringing it too near, as when they try to accommodate themselves to a feeble light. Not sufficient attention, we think, is given to these matters, especially when we consider the consequences of such habits in mature age. A large proportion of our defects originate in want of proper care during childhood. We do wrong to such wonderful tools as our senses when we do not give them the education they need. Is it not surprising that parents who are so particular about the way their children hold their fork or spoon pay so little attention to the way they use their eyes?

Stone Chips.—Describing to the American Association the aboriginal stone implements of the Potomac Valley, Washington, D. C., Mr. W. H. Holmes said that they were of soapstone, quartz, and quartzite. The Algonquin peoples quarried the soapstone to get stuff for vessel-making. The quartz and quartzite were made into spear-heads, arrow-points, and knives, and the material was obtained from bowlders dug from the bluffs. In shaping the implements, which was done by percussion, thousands of stones were thrown aside because of flaws. Leaf-shaped blades were made at the quarries and carried to the villages to be finished. When the village was at the quarry-site, relics of all the stages of progress were found in the refuse. Where the villages were not located on the quarry-sites, no rude forms were found, but only the blades and the fully finished tools made from them. Hence, the author contended, the rude forms of chipped stones are not tools at all; and the difference between the "rough stone age" and the "smooth stone age," insisted upon by French archæologists, disappears. Mr. Holmes was supported by Prof. Putnam, but Dr. O. L. Mason was not ready to see their theory so summarily disposed of.

Our Most Usual Words.—Prof. Jastrow communicated to the American Association a curious study of processes involved in every-day mental life. Twenty-five men and twenty-five women, students in a class in psychology, wrote as rapidly as possible the first hundred words that occurred to them. Of the five thousand words written only 2,024 words were different. Twelve hundred and sixteen words occur but once in the lists. Omitting these, about three thousand of the words were formed by the repetition of only

758 words. Passing to an analysis of this "mental community," it becomes clear that it is greatest at the beginning of the list; that is, the habit was shown to be to write first the most common words, and, when these are exhausted, the more unusual ones. The lists of words drawn up by women were much more like one another than those written by the men. The women used only 1,123 different words, the men 1,376; the women wrote only 520 words occurring but once in the lists, the men 746. The lists also indicate the relative prominence of different classes of ideas and objects in the minds of the writers. The five best represented classes are names of animals, articles of dress, proper names, actions, and implements and utensils. The women contributed most largely to the class of articles of dress, having given 224 words in it, while the men wrote only 129. They showed equal favoritism for articles of food, in which they wrote 179 words to 53 by the men. The men showed fondness for implements and utensils, names of animals, and abstract terms. Among the links by which one word seemed to suggest its successor were associations by sound and community of classification. In five hundred mentions of the twenty words most frequently recurring, the word preceding the given word was the same in 111 cases, and the word following it in 145 cases.

NOTES.

According to the investigations of an Indian student of the Hindoo folk lore, published at Lucknow, it is believed that if a person is drowned, struck by lightning, bitten by a snake, or poisoned, or loses his life by any accident or by suicide, he goes instantly to hell. If he dies naturally on a bed or a roof, he becomes a *bhut*, or evil spirit; and with this belief care is taken on the approach of death to move the person carefully on to the floor. The earth is believed to be resting on the horns of a cow and the raised trunks of eight elephants, called *diggai*, or "elephants supporting the regions," and each of the cardinal and subcardinal points of the compass has its appropriate guardian. An eclipse is supposed to be produced by the occasional swallowing up of the sun or moon by the severed head of Rihu, son of a demon family, who was decapitated by Vishnu for disguising himself as a god and drinking nectar.

The new system of railway fares introduced in Austria and Hungary, as has been shown by Prof. E. J. James, gives the Austrian Empire the cheapest railway fares in the world. Under it the usual fare for third-class passengers is about six and a half mills a mile, or $6.50 for a thousand-mile trip. Commutation rates for local service are still lower. Thus workmen can travel to and from work on the railroad for two cents a trip, up to six miles; four cents up to twelve miles; six cents up to eighteen miles; eight cents up to twenty-four miles; and ten cents up to thirty miles. Yearly tickets good for thirty-mile trips are sold for $17.40. These rates have proved profitable to the railways, and under them the traffic has increased so rapidly that the accommodations are taxed to the uttermost. The system is commended to the attention of American railway managers.

The bush country of the South Island, New Zealand, is troubled by a periodical visitation of rats (*Mus maorium*), which appear in the spring every four years. They are considerably different in size and general appearance from the common brown rat, being less fierce in appearance, and weighing, in full-grown specimens, only about two ounces. They are slow and awkward in movement on the ground, but quite at home and extremely active in climbing trees. These they ascend with the nimbleness of flies, running out with amazing quickness to the very tips of the branches. Hence, when pursued, they invariably make for trees if any are in reach, or, if not, for anything that will take them from the ground—as when a rat, disturbed by a plow, ran up the horse-reins which were dragging on the ground. They betray themselves, when startled, by their cry—an indiscretion of which the common rat is rarely guilty.

Attention is called by L. W. Wigglesworth to the use of a squirrel's tail as a steering and balancing organ during its leaps through the air. A squirrel was observed by a friend of the author's, in leaping from the height of thirty-three feet to the ground, to cause itself, by curving its tail strongly to one side just before alighting, to swerve in its course, and so avoid some hard substance on which it would otherwise have fallen.

Experiments are being made in European navies with captive balloons as points of observation. From one sent up from a French ironclad, ships and the details of the neighboring coast could be seen, in clear weather, for twenty or twenty-five miles. With silk as the material of the cable by which it is held, the balloon could rise in calm weather to a height of four hundred yards. The subject has attracted the attention of the naval authorities in Germany and England.

Mr. C. B. Atwell says, in the American Microscopical Journal, that amœbas for laboratory purposes are obtained at the Northwestern University from the algæ of Lake Michigan. A quantity of the common alga (*Cladophora canalicularis*) is put into a tumbler of water and allowed to stand for six or eight days, when a white film or ooze appears upon it which teems with amœbas and other protozoa. It is sometimes possible, in the rich supply thus obtained, to observe six, eight, or ten amœbas in the field at once.

Most people are probably not aware that there is one at least of the well-known stars compared to which the sun is a mere pygmy. Sirius, the dog-star, which is also a sun, is believed to have nearly five thousand times the volume of our sun. Its immense distance, probably a hundred million millions of miles, makes such measurement as is applied to the planets impossible. Hence the above estimate is based on a comparison of the light of Sirius with that received from the sun. It is the most brilliant star in the heavens, being far brighter than the first magnitude, and its light has a greenish tinge. During the winter months the place to look for Sirius is in the southern heavens.

OBITUARY NOTES.

Prof. Alexander Winchell, of the University of Michigan, died at Ann Arbor, February 19th, in the sixty-first year of his age. He was born in North East, Dutchess County, N. Y.; was graduated from Wesleyan University in 1847, and taught natural science in several academies till 1854, when he became Professor of Physics and Civil Engineering in the University of Michigan. In the next year he was transferred to the chair of Geology, Zoölogy, and Botany in the same institution. He was made Director of the Geological Survey of Michigan in 1859, and again, when the work was resumed after the interruption by the war in 1869, but resigned from the position in 1871. He was made Chancellor of Syracuse University in 1873, but gave up the office in the next year to be Professor of Geology, Zoölogy, and Botany there. In 1879 he returned to the professorship in the University of Michigan. Without giving up his regular duties, he also served as Professor or Lecturer of Geology, etc., in the University of Kentucky from 1866 to 1869, and in Vanderbilt University from 1875 till 1879. His office in the latter institution was abolished when he was found to be an advocate of the doctrines of evolution and of pre-adamites. He lectured much, and wrote numerous papers on geology. Fourteen new fossil species were named after him. He established the Marshall Group in American geology. The list of his books and papers includes about two hundred titles. His most important scientific works were Sketches of Creation, 1870; a Geological Chart, 1870; Michigan, 1873; The Doctrine of Evolution, 1874; Reconciliation of Science and Religion, 1877; Pre-adamites, or a Demonstration of the Existence of Man before Adam, 1880; Sparks from a Geologist's Hammer, 1881; World Life, or Comparative Geology, 1883; Geological Excursions, or the Rudiments of Geology for Young Learners, 1884; Geological Studies, or Elements of Geology, 1886; and Walks and Talks in the Geological Field, 1886.

Prof. Felipe Poey y Aloy, the distinguished Cuban naturalist, died in Havana, January 28th, aged ninety-one years. For more than sixty years he had contributed papers on natural history to the French, Spanish, and Cuban scientific press, to the Academy of Natural Sciences of Philadelphia, the Annals of the New York Lyceum, and to other American scientific publications. His chief work was his Cuban Ichthyology, in twelve folio volumes, containing descriptions of about a thousand species of fish, many of them noticed for the first time. His papers are said by Prof. Jordan to be the most valuable contributions yet made to our knowledge of the fishes of the West Indies. Other works are a Geography of Cuba, which reached nineteen editions; a general geography, and an elementary work on mineralogy. A sketch of his life and an account of his works, by Prof. D. S. Jordan, who knew him well, and a portrait, were published in The Popular Science Monthly for August, 1884.

Gottlieb Studer, one of the founders of the Swiss Alpine Club and its honorary president, died at Berne on the 14th of December, in his eighty-seventh year. He was a zealous mountaineer before Alpine clubs existed, was famous for his exhaustive topographical knowledge of Switzerland, was a draughtsman as well as a writer, and was the author of a Panorama von Bern and of Ueber Eis und Schnee, in four volumes.

Dr. José Jeronimo Friano, who died in Paris last fall, had made, before visiting Europe in 1860, a valuable collection of five thousand species of plants of New Granada. His chief object in visiting Europe was to determine his plants and prepare a Flora of New Granada, and this he began publishing, with the late Prof. J. E. Planchon, as a Prodromus Floræ Novæ Gratensis. Being insufficiently provided with funds, he became engaged in consular and medical work, and his Flora was suspended. He also published a monograph on the Melastomaceæ, and studies on the Quinquinas.

Mr. Lant Carpenter, eldest son of the late Dr. William B. Carpenter, and himself a lecturer on scientific subjects, died about the 1st of January.

NIKOLAUS COPERNICUS.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XII. MIRACLES AND MEDICINE.

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PART II.

We have seen that during the middle ages, while various churchmen, building better than they knew, did something to lay foundations for medical study, the Church authorities, as a rule, did even more to thwart it among the very men who, had they been allowed liberty, would have cultivated it to the highest advantage.

Then, too, we find cropping out everywhere the feeling that, since supernatural means are so abundant, there is something irreligious in seeking cure by natural means: ever and anon we have appeals to Scripture, and especially to the case of King Asa, who trusted to physicians rather than to the priests of Jahveh, and so died. Hence it was that St. Bernard declared that monks who took medicine were guilty of conduct unbecoming to religion. Even the School of Salerno was held in aversion by multitudes of strict churchmen, since it prescribed rules for diet, thereby indicating a belief that diseases arose from natural causes and not from the malice of the devil; moreover, in the medical schools Hippocrates was studied, and he had especially declared that demoniacal possession is "nowise more divine, nowise more infernal, than any other disease": hence it was, doubtless, that Pope Innocent III, about the beginning of the thirteenth century, forbade physicians, under pain of excommunication, to undertake medical treatment without calling in ecclesiastical advice.

Out of this feeling had grown up another practice, which made the development of medicine still more difficult—the classing of scientific men generally with sorcerers and magic-mongers: from this largely rose the charge of atheism against physicians, which ripened into a proverb, *Ubi sunt tres medici, ibi sunt duo athei.**

Magic was so common a charge that many physicians seemed to believe it themselves: in the tenth century Gerbert, afterward known as Pope Sylvester II, was at once suspected of sorcery when he showed a disposition to scientific methods; in the eleventh century this charge nearly cost the life of Constantine Africanus when he broke from the beaten path of medicine; in the thirteenth it gave Roger Bacon, one of the greatest benefactors of mankind, many years of imprisonment, and nearly brought him to the stake; these cases are typical of very many.

Still another charge against physicians who showed a talent for investigation was that of Mohammedanism and Averroism; and Petrarch stigmatized Averroists as "men who deny Genesis and bark at Christ." †

The effect of this wide-spread ecclesiastical opposition was, that for many centuries the study of medicine was confined mainly to the lowest order of practitioners. There was, indeed, one orthodox line of medical evolution during the later middle ages; St. Thomas Aquinas insisted that the forces of the body are independent of its physical organization, and that therefore these forces are to be studied by the scholastic philosophy and the theological method instead of by researches into the structure of the body; as a result of this, mingled with survivals of various pagan superstitions, we have in anatomy and physiology such doctrines as the increase and decrease of the brain with the phases of the moon, the ebb and flow of human vitality with the tides of the ocean, the use of the lungs to fan the heart, the function of the liver as the seat of love, and that of the spleen as the center of wit.

Closely connected with these methods of thought was the doctrine of signatures: it was reasoned that the Almighty must have set his sign upon the various means of curing disease which He has provided: hence it was held that bloodroot, on account of its red juice, is good for the blood; liverwort, having a leaf like the liver, cures diseases of the liver; eyebright, being marked with a spot like an eye, cures diseases of the eyes; celandine, having a yellow juice, cures jaundice; bugloss, resembling a snake's head,

* [Where there are three physicians there are two atheists.] See Daunou, cited by Buckle in the Posthumous Works, vol. ii, p. 580.

† See Renan, Averroès et l'Averroisme, Paris, 1867, pp. 327–335. For a perfectly just statement of the only circumstances which can justify a charge of atheism, see Rev. Dr. Deems in Popular Science Monthly, February, 1876.

cures snake-bite; red flannel, looking like blood, is supposed to cure blood-taints, and therefore rheumatism; bear's grease, being taken from an animal thickly covered with hair, is recommended to persons fearing baldness.*

Still another injury was wrought by this theological pseudo-science. One of the ideas it evolved was that of disgusting the demon with the body which he tormented: hence the patient was made to swallow or apply to himself various unspeakable ordures, with such medicines as the livers of toads, the blood of frogs and rats, fibers of the hangman's rope, and ointment made from the body of gibbeted criminals. Many of these were survivals of heathen superstitions, but theologic reasoning wrought into them an orthodox significance. As an example of this mixture of heathen with Christian magic, we may cite the following from a mediæval medical book as a salve against "nocturnal goblin visitors": "Take hop plant, wormwood, bishopwort, lupine, ash-throat, henbane, harewort, viper's bugloss, heathberry plant, cropleek, garlic, grains of hedgerife, githrife, and fennel. Put these worts into a vessel, set them under the altar, sing over them nine masses, boil them in butter and sheep's grease, add much holy salt, strain through a cloth, throw the worts into running water. If any ill tempting occur to a man, or an elf or goblin night visitors come, smear his body with this salve, and put it on his eyes, and cense him with incense, and sign him frequently with the sign of the cross. His condition will soon be better." †

As to surgery, this same amalgamation of theology with survivals of pagan beliefs continued to check the evolution of medical science down to the modern epoch. The nominal hostility of the Church to the shedding of blood withdrew, as we have seen, from surgical practice the great body of her educated men; hence surgery remained down to the fifteenth century a despised profession, its practice continued largely in the hands of charlatans, and down to a very recent period the name "barber-surgeon" was a survival of this. In such surgery, the application of various

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* For a summary of the superstitions which arose under the theological doctrine of signatures, see Dr. Eccles's admirable little tract on the Evolution of Medical Science, p. 140. See also Scoffern, Science and Folk Lore, p. 76.

† For a list of unmentionable ordures used in Germany near the end of the seventeenth century, see Lammert, Volksmedizin und medizinischer Aberglaube in Bayern, Würzburg, 1869, p. 34, note. For the English prescription given, see Cockayne, Leechdoms, Wortcuring, and Starcraft of Early England, in the Master of the Rolls series, London, 1865, vol. ii, pp. 345 and following. Still another of these prescriptions given by Cockayne covers three or four octavo pages. For very full details of this sort of sacred pseudo-science in Germany, with accounts of survivals of it at the present time, see Wuttke, Prof. der Theologie in Halle, Der Deutsche Volksaberglaube der Gegenwart, Berlin, 1869, *passim*. For France, see Rambaud, pp. 371 *et seq*.

ordures relieved fractures; the touch of the hangman cured sprains; the breath of a donkey expelled poison; friction with a dead man's tooth cured toothache.*

The enormous development of miracles in the Church continued during century after century, and here probably lay the main causes of hostility between the Church on the one hand and the better sort of physicians on the other; namely, in the fact that the Church supposed herself in possession of something far better than scientific methods in medicine. Under the sway of this belief a natural and laudable veneration for the relics of Christian martyrs was developed more and more into pure fetichism.

Thus the water in which a single hair of a saint had been dipped was used as a purgative; water in which St. Remy's ring had been dipped cured fevers; wine in which the bones of a saint had been dipped cured lunacy; oil from a lamp burning before the tomb of St. Gall cured tumors; St. Valentine cured epilepsy; St. Christopher, throat diseases; St. Eutropius, dropsy; St. Ovid, deafness; St. Gervaise, rheumatism; St. Apollonia, toothache; St. Vitus, St. Anthony, and a multitude of other saints, the maladies which bear their names; even as late as 1784 we find certain authorities in Bavaria ordering that any one bitten by a mad dog should at once put up prayers at the shrine of St. Hubert, and not waste his time in any attempts at medical or surgical cure.† In the twelfth century we find a noted cure attempted by causing the invalid to drink water in which St. Bernard had washed his hands. Flowers which had rested on the tomb of a saint, when steeped in water, were supposed to be especially efficacious in various diseases. The pulpit everywhere dwelt with unction on the reality of fetich cures, and among the choice stories collected by Archbishop Jacques de Vitry for the use of preachers was one which, judging from its frequent recurrence in monkish literature, must have sunk deep into the popular mind: "Two lazy beggars, one blind the other lame, try to avoid the relics of St. Martin, borne about in procession, so that they may not be healed and lose their alms. The blind man takes the lame man on his shoulders to guide him, but they are caught in the crowd and healed against their will." ‡

Very important also throughout the middle ages were the

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* On the low estate of surgery during the middle ages, see the histories of medicine already cited, and especially Kotelmann, Gesundheitspflege im Mittelalter, Hamburg, 1890, pp. 216 *et seq.*

† See Baas, p. 614; also Biedermann.

‡ For the efficacy of flowers, see the Bollandist Lives of the Saints, cited in Fort, p. 279; also pp. 457, 458. For the story of those unwillingly cured, see the Exempla of Jacques de Vitry, edited by Prof. T. F. Crane, of Cornell University; London, 1890, pp. 52 and 182.

medical virtues attributed to saliva. The use of this remedy had early Oriental sanction. It is clearly found in Egypt. Pliny devotes a considerable part of one of his chapters to it; Galen approved it; Vespasian, when he visited Alexandria, is said to have cured a blind man by applying saliva to his eyes; but the great example impressed most forcibly upon the mediæval mind was the use of it ascribed in the fourth Gospel to Jesus himself: thence it came not only into church ceremonial, but largely into medical practice.*

As the theological atmosphere thickened, nearly every country had its long list of saints, each with a special power over some one organ or disease. The clergy, having great influence over the medical schools, conscientiously mixed this fetich medicine with the beginnings of science: in the tenth century, even at the School of Salerno, we find that the sick were cured not only by medicine, but by the relics of St. Matthew and others.

Human nature, too, asserted itself then as now, by making various pious cures fashionable for a time and then allowing them to become unfashionable. Just as we see the relics of St. Cosmo and St. Damian in great vogue during the early middle ages, but out of fashion and without efficacy afterward, so we find in the thirteenth century that the bones of St. Louis having come into fashion wrought multitudes of cures, while in the fourteenth, having become unfashionable, they ceased to act, and gave place for a time to the relics of St. Roch of Montpellier and St. Catherine of Sienna, which in their turn wrought many cures until they too became out of date and yielded to other saints. Just so in modern times the healing miracles of La Salette have lost prestige in some measure, and those of Lourdes have come into fashion.†

Even such serious matters as fractures, calculus, and difficult parturition, in which modern science has achieved some of its greatest triumphs, were then dealt with by relics; and to this hour the *ex votos* hanging at such shrines as those of St. Geneviève at Paris, of St. Antony at Padua, of the Druid image at Chartres, of the Virgin at Einsiedeln, in the cave of Lourdes, nay, even at the fountain of La Salette, in spite of the fact that

* As to the use of saliva in medicine, see Story, Castle of St. Angelo, and other essays, London, 1877, pp. 208, and elsewhere. For Pliny, Galen, and others, see the same, p. 211; see also the Book of Tobit, chap. xi, 2–13. For the case of Vespasian, see Suetonius, Life of Vespasian; also Tacitus, Historia, lib. iv, c. 81. For its use by St. Francis Xavier, see Coleridge, Life and Letters of St. Francis Xavier, London, 1872.

† For one of these lists of saints curing diseases, see Pettigrew, Medical Superstitions of the Middle Ages; for another, see Jacob, Superstitions Populaires, pp. 96–100; also Rydberg, p. 69; also Maury, Rambaud, and others. For a comparison of fashions in miracles with fashions in modern healing agents, see Littré, Médecine et Médecins, pp. 118, 136, and elsewhere; also Sprengel, vol. ii, p. 143.

thorough legal investigation has twice utterly disproved the miracle which gives sacredness to the place, are survivals of this same conception of disease and its cure.

So, too, with a multitude of sacred pools, streams, and spots of earth. In Ireland hardly a parish has not had one such sacred center; in England and Scotland there have been many; and as late as 1805 the eminent Dr. Milner, of the Roman Catholic Church, gave a careful and earnest account of a miraculous cure wrought at a sacred well in Flintshire. In all parts of Europe the pious resort to wells and springs continued long after the close of the middle ages, and has not entirely ceased to-day.

As to all these the argument was simply this: if the Almighty saw fit to raise the dead man who touched the bones of Elisha, why should He not restore to life the patient who touches at Cologne the bones of the Wise Men of the East who followed the star of the Nativity? If Naaman was cured by dipping himself in the waters of the Jordan, and so many others by going down into the Pool of Siloam, why should not men still be cured by bathing in pools which men equally holy with Elisha have consecrated? If one sick man was restored by touching the garments of St. Paul, why should not another sick man be restored by touching the seamless coat of Christ at Treves, or the winding-sheet of Christ at Bésançon? And out of all these inquiries came inevitably that question whose logical answer was especially injurious to the development of medical science: Why should men seek to build up scientific medicine and surgery, when relics, pilgrimages, and sacred observances, according to an overwhelming mass of concurrent testimony, have cured and are curing hosts of sick people in all parts of Europe? *

Still another development of the theological spirit, mixed with professional exclusiveness and mob prejudice, wrought untold injury. Even to those who had become so far emancipated from allegiance to fetich cures as to consult physicians, it was forbidden to consult those who, as a rule, were the best. From a very early period of European history the Jews had taken the lead in

* For sacred fountains in modern times, see Pettigrew, as above, p. 42; also, Dalyell, Darker Superstitions of Scotland, pp. 82 and following; also, Montalembert, Les Moines d'Occident, t. iii, p. 323, note. For those in Ireland, with many curious details, see S. C. Hall, Ireland, its Scenery and Character, London, 1841, vol. i, p. 282, and *passim*. For the case in Flintshire, see Authentic Documents relative to the Miraculous Cure of Winefrid White, of the Town of Wolverhampton, at Holywell, Flintshire, on the 28th of June, 1805, by John Milner, D. D., Vicar Apostolic, etc., London, 1805. For sacred wells in France, see Chevart, Histoire de Chartres, vol. i, pp. 84–89, and French local histories generally. For superstitions attaching to springs in Germany, see Wuttke, Volksaberglaube, §§ 12 and 356. For one of the most exquisitely wrought works of modern fiction, showing perfectly the recent evolution of miraculous powers in a fashionable spring in France, see Gustave Droz, Autour d'Une Source.

medicine; their share in founding the great Schools of Salerno and Montpellier we have already noted; and in all parts of Europe we find them acknowledged leaders in the healing art. The Church authorities, enforcing the spirit of the time, were especially severe against these benefactors: that men who openly rejected the means of salvation, and whose souls were undeniably lost, should heal the elect, seemed an insult to Providence; preaching friars denounced them from the pulpit, and the rulers in state and Church, while frequently secretly consulting them, openly proscribed them. Popes Eugene IV, Nicholas V, and Calixtus III especially forbade Christians to employ them. The Councils of Béziers and Alby in the thirteenth century, the Council of Avignon in the fourteenth, the Synod of Bamberg and the Bishop of Passau in the fifteenth, with many others, expressly forbade the faithful to call Jewish physicians or surgeons, under penalty of excommunication: such great preachers as John Geyler and John Herolt thundered from the pulpit against them and all who consulted them. As late as the middle of the seventeenth century, when the city council of Hall, in Würtemberg, gave some privileges to a Jewish physician "on account of his admirable experience and skill," the clergy of the city joined in a protest, declaring that "it were better to die with Christ than to be cured by a Jew doctor aided by the devil." Still, in their extremity, bishops, cardinals, kings, and even popes, insisted on calling in physicians of the hated race.*

Nor did the Reformation immediately change the sacred theory of medicine. Luther, as is well known, again and again ascribed his own disease to "devils' spells," declaring that "Satan produces all the maladies which afflict mankind, for he is the prince of death," and that "he poisons the air"; but that "no malady comes from God." From that day down to the faith cures of Boston, Old Orchard, and among the sect of "Peculiar People" in our own time, we see the results among Protestants

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* For the general subject of the influence of theological ideas upon medicine, see Fort, History of Medical Economy during the Middle Ages, New York, 1883, chapters xiii and xviii; also Collin de Plancy, Dictionnaire des Reliques, *passim;* also Raimbaud, Histoire de la Civilisation en France, Paris, 1885, vol. i, chap. xviii; also Sprengel, vol. ii, p. 345, and elsewhere; also Baas and others. For the eminence of Jewish physicians, and proscription of them, see Beugnot, Les Juifs d'Occident, Paris, 1824, pp. 76–94; also Bédarride, Les Juifs en France, en Italie, et en Espagne, chapters v, viii, x, and xiii; also Rénouard, Histoire de la Médecine, Paris, 1846, tome i, p. 439; also, especially, Lammert, Volksmedizin, etc., in Bayern, p. 6, note. For denunciations of them by Geyler and others, see Kotelmann, Gesundheitspflege im Mittelalter, pp. 194, 195. For a list of kings and popes who persisted in having Jewish physicians, and for other curious information of the sort, see Prof. Levi de Vercelli, Cristiani ed Ebrei nel Medio Evo, pp. 200–207; and for a very valuable summary, see Lecky, History of Rationalism in Europe, vol. ii, pp. 265–271.

of seeking the cause of disease in Satanic influence and its cure in fetichism.

Yet Luther, with his sturdy common sense, broke away from one belief which has interfered with the evolution of medicine from the dawn of Christianity until now. When that troublesome declaimer, Carlstadt, declared that "whoso falls sick shall use no physic, but commit his case to God, praying that His will be done," Luther asked, "Do you eat when you are hungry?" and the answer being in the affirmative, he continued, "Even so you may use physic, which is God's gift just as meat and drink is, or whatever else we use for the preservation of life." *

But perhaps the best-known development of this theological view in the Protestant Church was that mainly evolved in England out of a French germ of theological thought—a belief in the efficacy of the royal touch in sundry diseases, especially epilepsy and scrofula, the latter being consequently known as the king's evil. This mode of cure began, so far as history throws light upon it, with Edward the Confessor in the eleventh century, and came down from reign to reign, passing from the Catholic saint to Protestant debauchees upon the English throne, with ever-increasing miraculous efficacy.

Testimony to the reality of these cures is overwhelming. As a simple matter of fact, there are no miracles of healing in the history of the human race more thoroughly attested than those wrought by the touch of Henry VIII, Elizabeth, the Stuarts, and especially by that chosen vessel, Charles II. Though Elizabeth could not bring herself fully to believe in the reality of these cures, Dr. Tooker, the Queen's chaplain, and later Dean of Lichfield, testifies fully of his own knowledge to the cures wrought by her, though he confesses that she was somewhat skeptical. William Clowes, the Queen's surgeon, also testifies fully to them. Fuller, in his Church History, gives an account of a Roman Catholic who was thus cured by the Queen's touch and converted to Protestantism. Similar testimony exists as to cures wrought by James I. Charles I also enjoyed the same power, in spite of the public declaration against its reality by Parliament. In one case the King saw a patient in the crowd, too far off to be touched, and simply said, "God bless thee and grant thee thy desire"; whereupon, it is asserted, the blotches and humors disappeared from the patient's body and appeared in the bottle of medicine which he held in his hand; at least so says Dr. John Nicholas, Warden of Winchester College, who declares this of his own knowledge to be every word of it true.

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* For Luther's belief and his answer to Carlstadt, see his Table Talk, especially in Hazlitt's edition, pp. 250–257; also in his letters *passim*. For recent "faith cures," see Dr. Buckley's article on Faith Healing and Kindred Phenomena in The Century, 1886.

But the most incontrovertible evidence of this miraculous gift is found in the case of Charles II, the most thoroughly cynical debauchee who ever sat on the English throne before the advent of George IV. He touched nearly one hundred thousand persons, and the outlay for gold medals issued to the afflicted on these occasions rose in some years as high as ten thousand pounds. John Brown, surgeon in ordinary to his Majesty and to St. Thomas's Hospital, and author of many learned works on surgery and anatomy, published accounts of sixty cures due to the touch of this monarch; and Sergeant-Surgeon Wiseman devotes an entire book to proving the reality of these cures, saying, "I myself have been frequent witness to many hundreds of cures performed by his Majesty's touch alone without any assistance of chirurgery, and these many of them had tyred out the endeavours of able chirurgeons before they came thither." Yet it is especially instructive to note that while in no other reign were so many people touched for scrofula, and in none were so many cures vouched for, in no other reign did so many people die of that disease: the bills of mortality show this clearly, and the reason doubtless is the general substitution of supernatural for scientific means of cure. This is but one out of many examples showing the havoc which a scientific test always makes among miracles if men allow it to be applied.

To James II the same power continued; and if it be said, in the words of Lord Bacon, that "imagination is next of kin to miracle—a working faith," something else seems required to account for the testimony of Dr. Heylin to cures wrought by the royal touch upon babes in their mothers' arms. Myth-making and marvel-mongering were evidently at work here as in so many other places, and so great was the fame of these cures that we find, in the year before James was dethroned, a pauper at Portsmouth, New Hampshire, petitioning the General Assembly to enable him to make the voyage to England in order that he might be healed by the royal touch.

The change in the royal succession does not seem to have interfered with the miracle; for, though William III evidently regarded the whole thing as a superstition, and on one occasion is said to have touched a patient, saying to him, "God give you better health and more sense," Whiston assures us that this person was healed, notwithstanding William's incredulity.

As to Queen Anne, Dr. Daniel Turner, in his Art of Surgery, relates that several cases of scrofula which had been unsuccessfully treated by himself and Dr. Charles Bernard, sergeant-surgeon to her Majesty, yielded afterward to the efficacy of the Queen's touch. Naturally does Collier, in his Ecclesiastical History, say regarding these cases that to dispute them "is to come to the extreme of skepticism, to deny our senses and be incredulous even to ridiculousness." Testimony to the reality of these cures is indeed overwhelming, and a multitude of most sober scholars, divines, and doctors of medicine declared the evidence absolutely convincing. That the Church of England accepted the doctrine of the royal touch is witnessed by the special service provided in the Prayer-Book of that period for occasions when the King exercised this gift. The ceremony was conducted with great solemnity and pomp; during the reading of the service and at the laying on of the King's hands, the attendant bishop or priest recited the words, "They shall lay their hands on the sick and they shall recover"; afterward came special prayers, the Epistle and Gospel, with the blessing, and finally his Majesty washed his royal hands in golden vessels which high noblemen held for him.

In France, too, the royal touch continued, with similar testimony to its efficacy. On a certain Easter Sunday, that pious king, Louis XIV, touched about sixteen hundred persons at Versailles.

This curative power was then acknowledged far and wide, by Catholics and Protestants alike, upon the Continent, in Great Britain, and in America; and it descended not only in spite of the transition of the English kings from Catholicism to Protestantism, but in spite of the transition from the legitimate sovereignty of the Stuarts to the illegitimate succession of the house of Orange. And yet, within a few years after the whole world held this belief it was dead; it had shriveled away in the increasing scientific light at the beginning of the eighteenth century.*

We may now take up more in detail the evolution of medical science out of the mediæval view and its modern survivals. All through the middle ages, as we have seen, some few laymen and ecclesiastics here and there, braving the edicts of the Church and popular superstition, persisted in medical study and practice; this was especially seen at the greater universities, which had become somewhat emancipated from ecclesiastical control. In the thirteenth century the University of Paris gave a strong impulse to the teaching of medicine, and in that and the following

* For the royal touch, see Becket, Free and Impartial Inquiry into the Antiquity and Efficacy of Touching for the King's Evil, 1722, cited in Pettigrew, p. 147, and elsewhere. Also, Scoffern, Science and Folk Lore, London, 1870, pp. 413 and following. Also, Adams, The Healing Art, London, 1887, vol. ii; and especially Lecky, History of European Morals, vol. i, chapter on the Conversion of Rome; also his History of England in the Eighteenth Century, vol. i, chap. i. For curious details regarding the mode of conducting the ceremony, see Evelyn's Diary; also, Lecky, as above. For the royal touch in France, and for a claim to its possession in feudal times by certain noble families, see Rambaud, Hist. de la Civ. Française, p. 375.

century we begin to find the first intelligible reports of medical cases since the coming in of Christianity.*

During the fifteenth and beginning of the sixteenth centuries the revival of learning, the invention of printing, and the great voyages of discovery gave a new impulse to thought, and in this medical science shared: the old theological way of thinking was greatly questioned, and gave place in many quarters to a different way of looking at the universe.

In the sixteenth century Paracelsus appears—a great genius, doing much to develop medicine beyond the reach of sacred and scholastic tradition, though still fettered by many superstitions. More and more, in spite of theological dogmas, came a renewal of anatomical studies by dissection of the human subject. The practice of the old Alexandrian School was thus resumed. Mundinus dared use the human subject occasionally in his lectures; but finally came a far greater champion of scientific truth, Andreas Vesalius, founder of the modern science of anatomy. The battle waged by this man is one of the glories of our race.

From the outset Vesalius proved himself a master. In the search for real knowledge he braved the most terrible dangers, and especially the charge of sacrilege, founded upon the teachings of the Church for ages. As we have seen, even such men in the early Church as Tertullian and St. Augustine held anatomy in abhorrence, and Pope Boniface VIII interdicted dissection as sacrilege, threatening excommunication against those practicing it. Through this sacred conventionalism Vesalius broke without fear; despite ecclesiastical censure and popular fury, he studied his science by the only method that could give useful results. No peril daunted him. To secure the material for his investigations, he haunted gibbets and charnel-houses, risking the fires of the Inquisition and the virus of the plague: first of all men he began to place the science of human anatomy on its solid, modern foundations—on careful examination and observation of the human body: this was his first great sin, and it was soon aggravated by one considered even greater.

Perhaps the most unfortunate thing that has ever been done for Christianity is the tying it to forms of science which are doomed and gradually sinking. Just as, in the time of Roger Bacon, excellent men devoted all their energies to binding Christianity to Aristotle—just as, in the time of Reuchlin and Erasmus, they insisted on binding Christianity to Thomas Aquinas—so, in the time of Vesalius, such men made every effort to link Christianity to Galen. The cry has been the same in all ages; it is the same which we hear in this age for curbing scientific studies; the

* For the promotion of medical science and practice, especially in the thirteenth century, by the universities, see Baas, pp. 222–224.

cry for what is called "sound learning." Whether standing for Aristotle against Bacon, or for Aquinas against Erasmus, or for Galen against Vesalius, or for making mechanical Greek verses instead of studying the handiwork of the Almighty, the cry is always for "sound learning": the idea always is that these studies are "*safe*."

At twenty-eight years of age Vesalius gave to the world his great work on human anatomy. With it ended the old and began the new: its researches, by their thoroughness, were a triumph of science; its illustrations, by their fidelity, were a triumph of art.

To shield himself, as far as possible, in the battle which he foresaw must come, Vesalius dedicated the work to the Emperor Charles V, and in his dedicatory preface he argues for his method, and against the parrot repetitions of the mediæval text-books; he also condemns the wretched anatomical preparations and specimens made by physicians who utterly refused to advance beyond the ancient master. The parrot-like repeaters of Galen gave battle at once. After the manner of their time their first missiles were epithets; and, the almost infinite magazine of these having been exhausted, they began to use sharper weapons—weapons theologic.

In this case there were especial reasons why the theological authorities felt called upon to intervene. First, there was the old idea prevailing in the Church, sanctioned by one at least of the popes, that the dissection of the human body is forbidden to Christians: this was used with great force against Vesalius; but he at first gained a temporary victory; for a conference of divines having been asked to decide whether dissection of the human body is sacrilege, gave a decision in the negative.

The reason was simple: the great Emperor Charles V had made Vesalius his physician and could not spare him; but, on the accession of Philip II to the throne of Spain and the Netherlands, the whole scene changed: the bigots were now sure to have their way.

Another theological idea barred his path. Throughout the middle ages it was believed that there exists in man a bone imponderable, incorruptible, incombustible, the necessary nucleus of the resurrection body. Belief in a resurrection of the physical body, despite St. Paul's Epistle to the Corinthians, had been incorporated into the formula made many centuries after his time and called the Apostles' Creed, and was held throughout Christendom, "always, everywhere, and by all." This hypothetical bone was therefore held in great veneration, and many anatomists sought to discover it; but Vesalius, revealing so much else, did not find it, and was therefore suspected of a want of proper faith. He contented himself with saying that he left the question regarding the existence of such a bone to the theologians. He could not lie, he did not wish to fight the Inquisition, and thus he fell under suspicion.

The strength of this theological point may be judged from the fact that no less eminent a surgeon than Riolan consulted the executioner to find out whether, when he burned a criminal, all the parts were consumed; and only then was the answer received which fatally undermined this superstition. Still, in 1689 we find it still lingering in France, creating an energetic opposition in the Church to dissection. Even as late as the eighteenth century, Bernouilli having shown that the living human body constantly undergoes a series of changes, so that all its particles are renewed in a given number of years, so much ill feeling was drawn upon him, especially from the theologians, who saw in this statement danger to the doctrine of the resurrection of the body, that for the sake of peace he struck out his argument on this subject from his collected works.*

Still other encroachments upon the theological view were made by the new school of anatomists, and especially by Vesalius. During the middle ages there had been developed various theological doctrines regarding the human body; these were based upon arguments showing what the body ought to be, and naturally, when anatomical science showed what it is, these doctrines fell. An example of such popular theological reasoning is seen in a wide-spread belief of the twelfth century, that during the year in which the cross of Christ was taken by Saladin, children, instead of having thirty or thirty-two teeth as before, had twenty or twenty-two. So, too, in Vesalius's time another doctrine of this sort was dominant: it had long been held that Eve, having been made by the Almighty from a rib taken out of Adam's side, there must be one rib fewer on one side of every man than on the other. It was also held upon the authority of Genesis that the Almighty created man literally out of the dust of the earth, and breathed life into his nostrils. This twofold creation was a favorite subject with illuminators of missals, and especially with those who illustrated Bibles and religious books in the first

* For the resurrection bone, see Desmazes, Supplices, Prisons et Graces en France, Paris, 1866, p. 162. For Vesalius, see especially Portal, Hist. de l'Anatomie et de la Chirurgie, Paris, 1770, tome i, p. 407. Also Henry Morley, in his Clement Marot, and other essays. For Bernouilli and his trouble with the theologians, see Wolf, Biographien zur Culturgeschichte der Schweiz, vol. ii, p. 95. How different Mundinus's practice of dissection was from that of Vesalius may be seen by Cuvier's careful statement that the entire number of dissections by the former was three; the usual statement is that there were but two. See Cuvier, Hist. des Sci. Nat., tome iii, p. 7; also Sprengel, Frédault, Hallam, and Littré; also Whewell, Hist. of the Inductive Sciences, vol. iii, p. 328; also, for a very full statement regarding the agency of Mundinus in the progress of anatomy, see Portal, vol. i, pp. 209–216.

years after the invention of printing; but Vesalius and the anatomists who followed him put an end among thoughtful men to this belief in the missing rib, and in doing this dealt a blow at much else in the sacred theory. Naturally, all these considerations brought the forces of ecclesiasticism against the innovators in anatomy.*

A new weapon was now forged: Vesalius was charged with dissecting a living man, and, either from direct persecution, as the great majority of authors assert, or from indirect influences, as the recent apologists for Philip II admit, he became a wanderer: on a pilgrimage to the Holy Land, apparently undertaken to atone for his sin, he was shipwrecked, and in the prime of his life and strength he was lost to the world.

And yet not lost. In this century the painter Hamann has again given him to us. By the magic of Hamann's pencil Vesalius again stands on earth, and we look once more into his cell. Its windows and doors, bolted and barred within, betoken the storm of bigotry which rages without; the crucifix, toward which he turns his eyes, symbolizes the spirit in which he labors; the corpse of the plague-stricken beneath his hand ceases to be repulsive; his very soul seems to send forth rays from the canvas, which strengthen us for the good fight in this age.†

He was hunted to death by men who conscientiously supposed that he was injuring religion: his poor, blind foes destroyed one of religion's greatest apostles. What was his influence on religion? He substituted, for the repetition of worn-out theories, a conscientious and reverent search into the works of the great Power giving life to the universe; he substituted for representations of the human structure—pitiful and unreal—representations revealing truths most helpful to the whole human race.‡

The death of this champion seems to have virtually ended the contest. Licenses to dissect soon began to be given by sundry popes to universities, and renewed at intervals of from three to four years, until the Reformation released science from this yoke.

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* As to the supposed change in the number of teeth, see the Gesta Philippi Augusti Francorum Regis, . . . descripta a magistro Rigordo, 1219, edited by Father Francis Duchesne, in Historiæ Francorum Scriptores, tom. v, Paris, 1649, p. 24. For representations of Adam created by the Almighty out of a pile of dust and of Eve created from a rib of Adam, see the earlier illustrations in the Nuremberg Chronicle.

† The original painting of Vesalius at work in his cell, by Hamann, is now at Cornell University.

‡ For a curious example of weapons drawn from Galen and used against Vesalius, see Lewes, Life of Goethe, p. 343, note. For proofs that I have not overestimated Vesalius, see Portal, *ubi supra*. Portal speaks of him as "*le génie le plus droit qu'eut l'Europe*"; and again, "*Vesale me paraît un des plus grands hommes qui ait existé.*" For the use of the charge that anatomists dissected living men—against men of science before Vesalius's time—see Littré's chapter on Anatomy.

I hasten now to one of the most singular struggles of medical science during modern times. Early in the last century Boyer presented inoculation as a preventive of small-pox in France, and thoughtful physicians in England, inspired by Lady Montagu and Maitland, followed his example. Ultra-conservatives in medicine took fright at once on both sides of the Channel, and theology was soon finding profound reasons against the new practice. The French theologians of the Sorbonne solemnly condemned it; the English theologians were most loudly represented by the Rev. Edward Massey, who in 1772 preached and published a sermon entitled The Dangerous and Sinful Practice of Inoculation. In this he declared that Job's distemper was probably confluent small-pox; that he had been inoculated doubtless by the devil; that diseases are sent by Providence for the punishment of sin; and that the proposed attempt to prevent them is "a diabolical operation." Not less vigorous was the sermon of the Rev. Mr. Delafaye, entitled "Inoculation an Indefensible Practice." This struggle went on for thirty years. Yet it is a pleasure to note some churchmen—and among them Madox, Bishop of Worcester—giving battle on the side of right reason; but as late as 1753 we have a noted rector at Canterbury denouncing inoculation from his pulpit in the primatial city, and many of his brethren following his example.

The same opposition was vigorous in Protestant Scotland. The great majority of ministers joined in denouncing the new practice as "flying in the face of Providence," and "endeavoring to baffle a divine judgment."

On our own side of the ocean, also, this question had to be fought out. About the year 1721 Dr. Zabdiel Boylston, a physician in Boston, made an experiment in inoculation, one of his first subjects being his own son. He at once encountered bitter hostility, so that the selectmen of the city forbade him to repeat the experiment. Foremost among his opponents was Dr. Douglas, a Scotch physician, supported by the medical profession and the newspapers. The violence of the opposing party knew no bounds; they insisted that inoculation was "poisoning," and they urged the authorities to try Dr. Boylston for murder. Having thus settled his case for this world, they proceeded to settle it for the next, insisting that "for a man to infect a family in the morning with small-pox and to pray to God in the evening against the disease is blasphemy"; that the small-pox is "a judgment of God on the sins of the people," and that "to avert it is but to provoke him more"; that inoculation is "an encroachment on the prerogatives of Jehovah, whose right it is to wound and smite." Among the mass of scriptural texts most remote from any possible bearing on the subject one was employed which was equally cogent against any use of healing means in any disease—the words of Hosea: "He hath torn and he will heal us; he hath smitten and he will bind us up."

So bitter was this opposition that Dr. Boylston's life was in danger; it was considered unsafe for him to be out of his house in the evening; a lighted grenade was even thrown into the house of Cotton Mather, who had favored the new practice, and had sheltered another clergyman who had submitted himself to it.

To the honor of the Puritan clergy of New England, it should be said that many of them were Boylston's strongest supporters. Increase and Cotton Mather had been among the first to move in favor of inoculation, the latter having called Boylston's attention to it; and at the very crisis of affairs six of the leading clergymen of Boston threw their influence on Boylston's side and shared the obloquy brought upon him. Although the gainsayers were not slow to fling into the faces of the Mathers their action regarding witchcraft, arguing that their credulity in that matter argued credulity in this, they persevered, and among the many services rendered by the clergymen of New England to their country, this ought certainly to be remembered; for these men had to withstand, shoulder to shoulder with Boylston and Benjamin Franklin, the same weapons which were hurled at the supporters of inoculation in Europe—charges of "unfaithfulness to the revealed law of God."

The facts were soon very strong against the gainsayers: within a year or two after the first experiment nearly three hundred persons had been inoculated by Boylston in Boston and neighboring towns, and out of these only six had died; whereas, during the same period, out of nearly six thousand persons who had taken small-pox naturally, and had received only the usual medical treatment, nearly one thousand had died. Yet even here the gainsayers did not despair, and, when obliged to confess the success of inoculation, they simply fell back upon a new argument, and answered: "It was good that Satan should be dispossessed of his habitation which he had taken up in men in our Lord's day, but it was not lawful that the children of the Pharisees should cast him out by the help of Beelzebub. We must always have an eye to the matter of what we do as well as the result, if we intend to keep a good conscience toward God." But the facts were too strong; the new practice made its way in the New World as in the Old, though bitter opposition continued, and in no small degree on vague scriptural grounds, for more than twenty years longer.*

* For the general subject, see Sprengel, Histoire de la Médecine, vol. vi, pp. 39–80. For the opposition of the Paris Faculty of Theology to inoculation, see the Journal de

The steady evolution of scientific medicine brings us, next, to the discovery of vaccination by Jenner. Here, too, sundry vague survivals of theological ideas caused many of the clergy to side with retrograde physicians. Perhaps the most virulent of Jenner's enemies was one of his professional brethren, Dr. Moseley, who placed on the title-page of his book, Lues Bovilla, as a motto, referring to Jenner and his followers, "Father, forgive them, for they know not what they do"; this book of Dr. Moseley was especially indorsed by the Bishop of Dromore. In 1798 an Anti-vaccination Society was formed by physicians and clergymen, who called on the people of Boston to suppress vaccination, as "bidding defiance to Heaven itself, even to the will of God," and declared that "the law of God prohibits the practice." As late as 1803, the Rev. Dr. Ramsden thundered against vaccination in a sermon before the University of Cambridge, mingling texts of Scripture with calumnies against Jenner; but Plumptre and the Rev. Rowland Hill in England, Waterhouse in America, Thouret in France, Sacco in Italy, and a host of other good men and true, pressed forward, and at last science, humanity, and right reason gained the victory. Most striking results quickly followed. The diminution in the number of deaths from the terrible scourge was amazing. In Berlin, during the eight years following 1783, over four thousand children died of the small-pox; while during the eight years following 1814, after vaccination had been largely adopted, out of a larger number of deaths there were but five hundred and thirty-five who died of this disease. In Würtemberg, during the twenty-four years following 1772, one in thirteen of all the children died of small-pox, while during the eleven years after 1822 there died of it only one in sixteen hundred. In Copenhagen, during twelve years before the introduction of vaccination, fifty-five hundred persons died of small-pox, and during the sixteen years after its introduction only one hundred and

Barbier, vol. vi, p. 294; also the Correspondance de Grimm et de Diderot, vol. iii, pp. 259 *et seq.* For bitter denunciations of inoculation by the English clergy, and for the noble stand against them by Madox, see Baron, Life of Jenner, vol. i, pp. 231, 232, and vol. ii, pp. 39, 40. For the strenuous opposition of the same clergy, see Weld, History of the Royal Society, vol. i, p. 464, note. Also, for its comical side, see Nichols's Literary Illustrations, vol. v, p. 800. For the same matter in Scotland, see Lecky, History of the Eighteenth Century, vol. ii, p. 83. For New England, see Green, History of Medicine in Massachusetts, Boston, 1881, pp. 58 *et seq.* Also Chapter X of the Memorial History of Boston, by the same author and O. W. Holmes. For letter of Dr. Franklin, see Massachusetts Historical Collection, second Series, vol. vii, p. 17. Several most curious publications issued during the heat of the inoculation controversy have been kindly placed in my hands by the Librarians of Harvard College and of the Massachusetts Historical Society, among them A Reply to Increase Mather, by John Williams, Boston, printed by J. Franklin, 1721, from which the above scriptural arguments are cited. For the terrible virulence of the small-pox in New England up to the introduction of inoculation, see McMaster, History of the People of the United States, first edition, vol. i, p. 30.

fifty-eight persons died of it throughout all Denmark. In Vienna, where the average yearly mortality from this disease had been over eight hundred, it was steadily and rapidly reduced, until in 1803 it had fallen to less than thirty; and in London, formerly so afflicted by this scourge, out of all her inhabitants there died of it in 1890 but one. As to the world at large the result is summed up by one of the most honored English physicians of our time in the declaration that "Jenner has saved, is now saving, and will continue to save in all coming ages, more lives in one generation than were destroyed in all the wars of Napoleon."

It will have been noticed by those who have read this history thus far that the record of the Church generally was far more honorable in this struggle than in many which preceded it: the reason is not difficult to find; the decline of theology inured to the advantage of religion, and religion gave powerful aid to science.

Yet there have remained some survivals in both branches of the Western Church which may be regarded with curiosity. A small body of perversely ingenious minds in the medical profession in England have found a few ardent allies among the less intellectual clergy. The Rev. Mr. Rothery and the Rev. Mr. Allen, of the Primitive Methodists, have for sundry vague theological or metaphysical reasons especially distinguished themselves by opposition to compulsory vaccination; but it is only just to say that the great body of the clergy have at last taken the better view.

Far more painful has been the recent history of the other great branch of the Christian Church—a history developed where it might have been least expected; the recent annals of the world hardly present a more striking antithesis between Religion and Theology.

On the religious side few things in the history of the Roman Church have been so beautiful as the conduct of its clergy in Canada during the great outbreak of ship-fever among immigrants at Montreal about the middle of the present century. Day and night the Catholic clergy of that city ministered fearlessly to those victims of sanitary ignorance; fear of suffering and death could not drive these ministers from their work; they laid down their lives cheerfully while carrying comfort to the poorest and most ignorant of our kind: such was the record of their religion. But in 1885 a record was made by their theological spirit: in that year the small-pox broke out with great virulence at Montreal. The Protestant population escaped almost entirely by vaccination, but multitudes of their Catholic fellow-citizens, under some vague survival of the old orthodox ideas, refused vaccination and suffered fearfully. When at last the plague became so serious that travel and trade fell off greatly and quarantine began to be established in neighboring cities, an effort was made to enforce compulsory vaccination. The result was, that large numbers of the Catholic working population resisted and even threatened bloodshed. The clergy at first tolerated and even encouraged this conduct; the Abbé Filiatrault, priest of St. James's Church, declared in a sermon that, "if we are afflicted with small-pox, it is because we had a carnival last winter, feasting the flesh, which has offended the Lord; . . . it is to punish our pride that God has sent us small-pox." The clerical press went further: the Étendard exhorted the faithful to take up arms rather than submit to vaccination, and at least one of the secular papers was forced to pander to the same sentiment. The Board of Health struggled against this superstition, and addressed a circular to the clergy, imploring them to recommend vaccination; but, though two or three complied with this request, the great majority were either silent or openly hostile. The Oblate Fathers, whose church was situated in the very heart of the infected district, continued to denounce vaccination; the faithful were exhorted to rely on devotional exercises of various sorts; under the sanction of the hierarchy a great procession was ordered with a solemn appeal to the Virgin, and the use of the rosary was carefully specified.

Meantime, the disease, which had nearly died out among the Protestants, raged with ever-increasing virulence among the Catholics; and the truth becoming more and more clear, even to the most devout, proper measures were at last enforced and the plague was stayed, though not until there had been a fearful waste of life among these simple-hearted believers, and germs of skepticism planted in the hearts of their children which will bear fruit for generations to come.*

Another class of cases in which the theologic spirit has allied itself with the retrograde party in medical science is found in the history of certain remedial agents; and first may be named cocaine. As early as the middle of the sixteenth century the value of coca had been discovered in South America; the natives of Peru prized

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* For the opposition of conscientious men to vaccination in England, see Baron, Life of Jenner, as above; also vol. ii, p. 43. Also, Duns's Life of Simpson, London, 1873, pp. 248, 249. Also, Works of Sir J. Y. Simpson, vol. ii. For a multitude of statistics showing the diminution of small-pox after the introduction of vaccination, see Russell, p. 380. For the striking record in London for 1890, see an article in the Edinburgh Review for January, 1891. The general statement referred to was made in a speech some years since by Sir Spencer Wells. For recent scattered cases of feeble opposition to vaccination by Protestant ministers, see William White, The Great Delusion, London, 1885, *passim.* For opposition of the Roman Catholic clergy and peasantry in Canada to vaccination during the small-pox plague of 1885, see the English, Canadian, and American newspapers, but especially the very temperate and accurate correspondence in the New York Evening Post during September and October of that year.

it highly, and two Jesuits, Acosta and Don Antonio Julian, were converted to this view; but the conservative spirit in the Church was too strong; in 1567 the Second Council of Lima, consisting of bishops from all parts of South America, condemned it, and two years later came a royal decree declaring that "the notions entertained by the natives regarding it are an illusion of the devil."

As a pendant to this singular mistake on the part of the older Church came another committed by many leading Protestants. In the early years of the seventeenth century the Jesuit missionaries in South America learned from the natives the value of the so-called Peruvian bark in the treatment of ague; and in 1638 the Countess of Cinchona, Regent of Peru, having derived great benefit from the new remedy, it was introduced into Europe. Although with its alkaloid, quinine, it is perhaps the nearest approach to a medical specific, and has diminished the death-rate in certain regions to an amazing extent, its introduction was bitterly opposed by many conservative members of the medical profession, and in this opposition large numbers of ultra-Protestants joined, out of hostility to the Roman Church. In the heat of sectarian feeling the new remedy was stigmatized as "an invention of the devil"; and so strong was this opposition that the new medicine was not introduced into England until 1653, and even then its use was long held back, owing mainly to anti-Catholic feeling.

What the theological method on the ultra-Protestant side could do to help the world at this very time is seen in the fact that, while this struggle was going on, Hoffman was attempting to give a scientific theory of the action of the devil in causing Job's boils. This effort at a *quasi*-scientific explanation which should satisfy the theological spirit, comical as it at first seems, is really worthy of serious notice, because it must be considered as the beginning of that inevitable effort at compromise which we see in the history of every science when it begins to appear triumphant.*

But I pass to a typical conflict in our days, and in a Protestant country. In 1847 James Young Simpson, a Scotch physician, who afterward rose to the highest eminence in his profession, having advocated the use of anæsthetics in obstetrical cases, was immediately met by a storm of opposition. This hostility flowed from an ancient and time-honored belief in Scotland. As far back as the year 1591, Eufame Macalyane, a lady of rank, being charged

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* For the opposition of the South American Church authorities to the introduction of coca, etc., see Martindale, Coca, Cocaine, and its Salts, London, 1886, p. 7. As to theological and sectarian resistance to quinine, see Russell, pp. 194, 253. Also Eccles; also Meryon, History of Medicine, London, 1861, vol. i, p. 74, note. For the great decrease in deaths by fever after the use of Peruvian bark began, see statistical tables given in Russell, p. 252; and for Hoffman's attempt at compromise, ibid., p. 294.

with seeking the aid of Agnes Sampson for the relief of pain at the time of the birth of her two sons, was burned alive on the Castle Hill of Edinburgh; and this old theological view persisted even to the middle of the nineteenth century. From pulpit after pulpit Simpson's use of chloroform was denounced as impious and contrary to Holy Writ; texts were cited abundantly, the ordinary declaration being that to use chloroform was "to avoid one part of the primeval curse on woman." Simpson wrote pamphlet after pamphlet to defend the blessing which he brought into use; but the cause seemed about to be lost, when he seized a new weapon, probably the most absurd by which a great cause was ever won: "My opponents forget," he said, "the twenty-first verse of the second chapter of Genesis; it is the record of the first surgical operation ever performed, and that text proves that the Maker of the universe, before he took the rib from Adam's side for the creation of Eve, caused a deep sleep to fall on Adam." This was a stunning blow, but it did not entirely kill the opposition; they had strength left to maintain that the "deep sleep of Adam took place before the introduction of pain into the world—in a state of innocence." But now a new champion intervened—Thomas Chalmers; with a few pungent arguments from his pulpit he scattered the enemy forever, and the greatest battle of science against suffering was won. But this victory was won not less for religion: wisely did those who raised the monument at Boston to one of the discoverers of anæsthetics inscribe upon its pedestal the words from our sacred text, "This also cometh from the Lord of hosts, which is wonderful in counsel and excellent in working." *

Progress in medical science within the past quarter of a century has been vast indeed; the theological view of disease has greatly faded, and the theological hold upon medical education has been almost entirely relaxed. In three great fields especially, discoveries have been made which have done much to disperse the atmosphere of miracle. First, there has come in more knowledge regarding the relation between imagination and medicine, and, though still defective, it is of great importance. This relation has been noted during the whole history of the science. When the soldiers of the Prince of Orange, at the siege of Breda in 1625, were dying of scurvy by scores, he sent to the physicians "two or three small vials filled with a decoction of camomile, wormwood, and camphor, gave out that it was a very rare and precious medicine—a medicine of such virtue that two or three drops sufficed to impregnate a gallon of water, and that it had been obtained from the East with great difficulty and danger";

* For the case of Eufame Macalyane, see Dalyell, Darker Superstitions of Scotland, pp. 130, 133. For the contest of Simpson with Scotch ecclesiastical authorities, see Duns, Life of Sir J. Y. Simpson, London, 1873, pp. 215–222, and 256–260.

this statement, made with much solemnity, deeply impressed the soldiers; they took the medicine eagerly, and great numbers recovered rapidly. Again, two centuries later, young Humphry Davy, being employed to apply the bulb of the thermometer to the tongues of certain patients at Bristol, after they had inhaled various gases as a cure for disease, and finding that the patients supposed this application of the thermometer-bulb was the cure, finally wrought cures by this application alone, without any use of the gases whatever. Innumerable cases of this sort have thrown a flood of light upon such cures as those wrought by Prince Hohenlohe, by the "metallic tractors," and by a multitude of other agencies temporarily in vogue, but, above all, upon the miraculous cures which in past ages have been so frequent and of which a few survive.

The second department is that of Hypnotism. Within the last half-century many scattered indications have been collected and supplemented by thoughtful, patient investigators of genius, and especially by Braid in England and Charcot in France. Here too great inroads have been made upon the province hitherto sacred to miracle, and in 1888 the cathedral preacher, Steigenberger of Augsburg, sounded an alarm. He declared his fears "lest accredited church miracles lose their hold upon the public," denounced hypnotism as a doctrine of demons, and ended with the singular argument that, "inasmuch as hypnotism is avowedly incapable of explaining all the wonders of history, it is idle to consider it at all." But investigations in hypnotism still go on, and are to do much in the twentieth century to carry the world yet farther from the realm of the miraculous.

Finally, in a third field science has won a striking series of victories. Bacteriology, beginning in the researches of Leeuwenhoek in the seventeenth century, continued by O. F. Müller in the eighteenth, and developed or applied with wonderful power by Ehrenberg, Cohn, Pasteur, Koch, Lister, Billings, and their compeers in the nineteenth, has explained the origin, and proposed prevention or cure, for various diseases widely prevailing, which until recently have been generally held to be "inscrutable providences."

In summing up the history of this long struggle between Science and Theology two main facts are to be noted: First, that in proportion as the world approached the "Ages of Faith" it receded from ascertained truth, and in proportion as the world has receded from the "Ages of Faith" it has approached ascertained truth; secondly, that in proportion as the grasp of theology upon education tightened medicine declined, and in proportion as that grasp has relaxed medicine has been developed.

The world is hardly beyond the beginning of medical discoveries. Yet they have already taken from theology what was formerly its strongest province, sweeping away from this vast field of human effort that belief in miracles which for more than twenty centuries has been the main stumbling-block in the path of medicine; and, in doing this, they have cleared higher paths, not only for science, but for religion.*

OUR GRANDFATHERS DIED TOO YOUNG.

By Mrs. H. M. PLUNKETT.

THE chronic pessimist, who is convinced that all true wisdom died long ago with some old moldering ancestor, and who believes that the world and all its arrangements are daily waxing worse and worse, is frankly warned to skip this article, for he will find nothing in it to sustain his cheerless and pestilent views, nor to comfort his grumbling and disagreeable soul.

All students of vital statistics are now thoroughly agreed as to the actual lengthening of the average period of human life, and facts will be adduced to show on what their faith is grounded; and an attempt will be made to point out the many and encouraging factors that have helped to achieve the result.

In discussing so lofty a topic as the steady lengthening of human life in all civilized countries in these later times—properly rated as the highest earthly interest—it is almost humiliating to learn that the earliest revelation of the cheerful fact came through a thrill in the pocket-nerve.

In England, at the close of the first quarter of this century, it began to be perceived that the Government was losing money in paying its annuities calculated on the same basis as those that

* For rescue of medical education from the clutch of theology, especially in France, see Rambaud, La Civilisation Contemporaine en France, pp. 682, 683. For miraculous cures wrought by imagination, see Tuke, Influence of Mind on Body, vol. ii. For the opposition to scientific study of hypnotism, see Hypnotismus und Wunder: ein Vortrag, mit Weiterungen, von Max Steigenberger, Domprediger, Augsburg, 1888, reviewed in Science, February 15, 1889, p. 127. For a recent statement regarding the development of studies in hypnotism, see Liégois, De la Suggestion et de Somnambulisme dans leurs Rapports avec la Jurisprudence, Paris, 1889, chap. ii. As to the miraculous in general, for perhaps the most remarkable of all discussions on the subject, see Conyers Middleton, D. D., A Free Inquiry into the Miraculous Powers which are supposed to have subsisted in the Christian Church, London, 1749. For probably the most complete and judicially fair discussion of it, see Lecky, History of European Morals, vol. i, chap. iii; also his Rationalism in Europe, vol. i, chaps. i and ii; and for, perhaps, the boldest and most suggestive of recent statements regarding it, see Max Müller, Physical Religion, being the Gifford Lectures before the University of Glasgow for 1890, London, 1891, lect. xiv. See also, for very cogent statements and arguments, Matthew Arnold's Literature and Dogma, especially chap. v, and, for a recent utterance of great clearness and force, Prof. Osler's address before the Johns Hopkins University, given in Science for March 27, 1891.

had been sold in the last century. These annuities may be briefly described as the paying of a certain annual sum for a number of years calculated on the probable number of years the annuitant may live, in return for a "lump sum" given by him to the Government. Several such series of annuities had been issued by the Government when in dire distress for funds, and found highly profitable; but now it became apparent that the Government was losing money, and a searching inquiry by authorized experts, plainly showed that the men who were receiving the annuities were living too long--a state of things that demanded reform; and, as wholesale murder could not be indulged in, the problem was attacked from the other side, and by a more extended and careful set of investigations an equitable basis for the issuance of future annuities was found. At this time it was clearly shown that the duration of life in 1725 compared to that in 1825 was as three in the former to four in the later time.

We, who are born into this age of tabulated statistics, can form but a feeble notion of the slender grounds on which those misleading annuities were founded. True, more than five hundred years B. C. the Romans had begun a register of citizens, including sex and the dates of birth and death, which was continued for a thousand years; and, from a study of it, the average period of human life was computed at thirty years. There are no life-tables at all reliable now that are over fifty years old. The first English census worthy of the name was taken in 1851; but it is a curious and valuable circumstance that while Geneva in Switzerland was undergoing the inevitable ferment caused by the presence of such an agitator as John Calvin, she did, in 1551—just three centuries ahead of England—set up such a recording and tabulation of her citizens as makes the records invaluable as a means of comparison, and shows that, from a death-rate of forty in the thousand previous to 1600, it had fallen before 1800 to twenty-nine in the thousand, and there has been a steady decrease since; so that the average of human life in that city was computed fifty years ago at more than forty-five years—a gain of one half over the Roman average.

France also set herself at the problem of life-values. Baron Delessert—the founder of the Philanthropic Society of Paris—found that the annual death-rate in that city during the age of chivalry—the fourteenth century—was one in sixteen; during the seventeenth, one in twenty-six; and in 1824, one in thirty-two. Taking all of France together, the deaths during 1781 were one in twenty-nine; but in the five years preceding 1829 they were one in thirty-nine. Thus the value of life in France had nearly doubled since "the good *old* times."

It was next found that, in the prisons of England, which were already experiencing the good effects of greater cleanliness, better food, and other reforms, introduced through the efforts of Howard and his coadjutors, the health of the prisoners was so much benefited and their lives so much prolonged that, as Mr. Beecher said "people might sigh for a location in some good salubrious prison." So great were the advances on all sides, that Sir Edwin Chadwick, the father of sanitation, so far as it can be defined (Steps to abolish Disease and to defer Death), became persuaded that there is a potential longevity in men of one hundred years, and that death at a period less than that should be counted premature. He was born in 1800 and died July 5, 1890; and if it is true, as many statisticians assert, that the period of human life has lengthened nine years since this century began, we can see that his belief was not altogether the dream of an enthusiast; for, in spite of the great advances made in the science of sanitation, and in the art of living so as to insure the highest health, he felt that only a beginning had been made, and that the coming century is to be the one in which the seeds planted in this are to attain their growth and bear their full fruitage.

In seeking the reasons for this advance, they all might be summed up in the one great sweeping fact of the mastery of man over the forces of Nature, through the grand scientific triumphs that began with the discovery of oxygen in 1774, and the control of steam and electricity obtained a little later. When we come to details, we find the first great universal factor is the better supplies of food, produced in greater quantities and with less labor than formerly through the intelligent application of agricultural chemistry, and the use of the marvelous myriads of agricultural machines, which stand for armies of laborers, who don't get tired and don't eat. When a Montana farmer can grow on one prize acre nine hundred and seventy-four bushels of good potatoes, the disciples of Malthus even can take heart, for Mr. Edward Atkinson has conclusively demonstrated that the food-producing areas of this country have as yet only been scratched over and worked at one corner. In Queen Elizabeth's time a statistical writer says that in London the deaths from starvation were not more than one in a thousand. At that rate the deaths in London now would be twelve hundred and fifty annually, while the fact is that the few deaths from that cause now are from suicidal mania and obstinate refusal to make application for the relief provided for the destitute. Linked with the foregoing is the rapid intercommunication of nations and the speedy transportation which has practically put an end to the great famines which formerly destroyed millions in Europe and Asia, and paved the way for "plagues" in reducing the vitality of the inhabitants. A well-to-do American laborer can to-day command a more wholesome variety of nutritious food than could the lord of the middle ages.

Next, the invention of machinery has so increased the supplies of clothing, and increased intercommunication has so aided in its distribution, that the protection and comfort of mankind have been immeasurably enhanced, while a better knowledge of the hygiene of clothing has prolonged many a life. The single item of waterproof garments and rubber shoes has saved so many lives that the philanthropist ought to rejoice that just as the cry began to go up, "The Brazilian forests are becoming exhausted," Stanley opened up boundless stores of rubber in Africa.

The next great and widely operating cause of lengthened life has been the extensive application of drainage-works, undertaken primarily to give a higher agricultural value to land, but incidentally causing an abatement in fever and ague and all other types of malarial disease, and also greatly lessening the cases of consumption—as damp soil is now recognized as *the* great predisposing cause of lung diseases. In Birmingham, England, where the drainage was good, the deaths were one in forty, in spite of many insalubrious manufactories; while in Liverpool, where an undrained soil counteracted many sanitary advantages, they were one in thirty-one. By the drainage of the Bay Ridge district of Long Island, under an intelligent and judicious commission, not only were malarious swamps changed into fertile corn-fields, but the druggists testified that they sold one quarter only of the quinine used before, and the resident physicians that there was a cessation of chills and fever and all types of intermittent and remittent fever. It should be noted, in passing, that *all* the landowners joined; one obstinate obstructionist can nullify the good intentions of a multitude of right-minded men.

We now begin to come upon the widely operating reforms consequent on the investigations and recommendations of sanitarians; the first and greatest of which is the supply to multitudes of communities of pure water; sometimes tapping an uncontaminated supply by a pipe, and sometimes going below the element of danger by an artesian well or other method of securing protected water and thereby saving thousands from attacks of typhoid and fatal diarrhœal diseases. It is beginning to be learned that constantly drinking impure water creates a lowered vitality as much as breathing a vitiated air, and that either one helps to supply ready-made victims for any of the epidemic diseases.

The next great sanitary reform has been a knowledge of the true principles of ventilation. The need of pure air—air that has not previously been breathed by another person—is by no means as well understood as could be wished, but enlightenment is surely making its way, and ancient evils are vanishing before it. A whole article would be insufficient to show how knowledge on this subject, not understood in its rudiments fifty years ago, has advanced. Typhus, or ship fever, a disease most easily and directly communicable from person to person, is now known, when it arises spontaneously, to be the fruit of rebreathed air. It formed the "plagues" of the earlier centuries; there are still spots in London—infected houses—from which typhus is never absent, and in 1839 five per cent of the tailors of London died of it; it is to get rid of it, in large measure, that the wholesale demolition of London "rookeries" is at this moment going on. When men ceased to weave in their own unventilated hovels, and were gathered together in high, airy, light factory rooms, it was very soon seen that the number of consumptives, hunchbacks, and bow-legged diminished—an unanswerable testimony to the value of light and air in saving and prolonging lives. When it was shown that the annual death-rate from preventable typhus, which attacked persons in the vigor of life, was double that of the allied armies at Waterloo, England began to suspect that there was a commercial value to a man's life, and enacted laws for its protection; indeed, public sentiment on this matter has become so educated that no employer would dare to crowd eighty workmen into a space where the "cubic feet of air" to each was less than one hundred feet—less than one tenth of that required for healthful breathing. The reduction of the deaths of children in a single hospital, by having it well ventilated, from 2,944 out of a total of 7,650 down to 279, convinced the most stolid conservative that "there was something in it." It seems to an intelligent person of to-day as if everybody, everywhere, and all the time had understood the importance of pure air; but when it is remembered that the constitution of the atmosphere has been known only a little more than a hundred years, and the vital relations of oxygen to the human blood for a much shorter period, it will be seen that the idea is wide of the fact.

Systematic sanitation began in England about fifty years ago; in America about twenty—the first State Board of Health made its first report in 1870; but thoroughly informed persons declare that among our more plastic populations, where ideas do not encounter so many vested abuses and prejudices, they have made such rapid headway that we are already abreast of the most advanced sanitary thought of Europe; some of the new Western towns have sprung, like Minerva, in full completeness, from their creators, with entire equipment of pure water-supply, perfect drainage, electric lights, and houses built on the most healthful models.

The site of the dwelling has become an object of prime importance, and public opinion has forbidden the use of swamps as a fit place to locate the homes of artisans and laborers. The better construction of tenement-houses under the eye of vigilant sanitary inspectors has produced a truly marvelously diminished death-rate. In the mud hovels of Ireland—cabins of only one room—the average continuance of life was twenty-six and a half years, when in the rural cottages of English agricultural laborers it was from fifty to fifty-six. In the model homes for laborers that have been built within the last twenty years in London, the death-rate has been brought down lower than in the best parts of rural England. Chadwick says that houses in the wynds of Glasgow were in a worse condition than the most loathsome prisons Howard visited, with a death-rate of forty-two in the thousand; sanitation has brought it down to twenty-eight, and in corresponding quarters in London it has been brought down to seventeen or eighteen, and the rebuilding of the fifteen acres adjacent to Bethnal Green will reduce it still further.

House-drainage—synonymous with *properly constructed plumbing*—has justly engaged a large share of attention from the sanitarian. By thorough attention to it (her sewers and water-supply were right before) Boston has reduced her death-rate from thirty-one to twenty. Croydon, England, which had a death-rate of twenty-eight, has brought it down to thirteen. These are only specimens of what has become an almost universal movement among intelligent communities.

The next life-saving advance is the superior ease of warming our houses — made possible by the improved locomotion that brings the wealth of the coal-mines to our doors and enables us to maintain a steady fire from fall to spring, that diffuses a gentle warmth all over the house, and forestalls all possibility of "taking a chill" while waiting for the fire to kindle. Even the friction-match comes in for its share of the prolonging of life. Doubtless many a fatal pneumonia and pleurisy has been contracted when the luckless householder's fire had died out overnight, and he was struggling with flint, steel, and tinder-box. It is only half a century since the indispensable friction-match came into general use.

The comfort of the warmed, luxuriously furnished, storm-defying railroad-car, contrasted with the exposure and discomfort of the stage-coach, needs but to be alluded to.

Another factor that has contributed largely, no doubt, to the diminution of mortality is the cessation of intramural interments and the establishment of cemeteries—often justly described as "rural"—removed from the busy centers of population. There are no statistics on which to found a comparison, but the known chemical products of mortal decay, and the known porosity of the earth, are of themselves enough to convince the thinking man of the expediency of removing graveyards from the abodes of the living; and here and there among the annals of sanitation are instances of sickness and death that can be traced directly to their baneful proximity.

We next come to what may be called the medical and physiological ameliorations of the woes of humanity. Thousands and thousands of lives are now saved annually in the hospitals, refuges, homes, etc., provided by Christian charity, which have mostly come into being within the last century. Multitudes of lives have been saved by antiseptic surgery alone. The hospitals have afforded such facilities for the study of disease that a partial mastery has been gained over many, especially those known to be contagious, so that when an outbreak of one of these occurs it is soon confined to the smallest possible area; isolation and disinfection do much, and the private burial of persons so dying helps to limit the mischief. Of what may be called the medical control of disease, vaccination surpasses all others in its benefits. The deaths in London alone from small-pox during the last century fell but a trifle short of two hundred thousand, and so common was it that Macaulay says a person without a pitted face was the exception; while the numbers rendered blind, deaf, and hideous as well as wretched by it are pitiful to think of. In New York, in 1878, in a population of eleven hundred thousand, there were but fourteen cases, *thanks to vaccination;* and in the German army, where vaccination is compulsory and also revaccination at stated periods, the disease has been effectually eradicated. Anti-vaccination cranks are specially invited to read the above.

Sanitation, which works so beneficently among civilians, soon gets itself applied in the army and navy. The navies of the world furnish striking examples of the prolonging of life, and, as careful records are kept in them, it doesn't remain an ambiguous quantity. Discipline can enforce cleanliness both of the man and the ship, and a good example set in the ships of one country is soon followed in those of another. The production of pure distilled water on shipboard has done much to abolish alimentary diseases among sailors, and the power of vegetables and lime-juice to defend them from scurvy appeals to the selfishness of the ship-owners, though redounding to the long life of Jack. Dampness is one of man's mortal foes, and when it is aggravated by heat it becomes ten times worse. Damp heat between decks aggravates yellow fever and is the great cause of disease in the tropics. Formerly every day saw the decks washed down, but this operation is now left to the discretion of the commanding officer. The wisdom of this arrangement is apparent from the following record of Captain Murray, commander of H. B. M.'s ship Valorous: "In 1823, after two years' service amid the icebergs of Labrador, his ship was ordered to sail immediately for the West Indies. . . . He proceeded to the station with a crew of one hundred and fifty men, visited almost every island in the West Indies and many of the ports in the Gulf of Mexico; and, notwithstanding the transition from extreme climates, returned to England without the loss of a single man." He adds that "every precaution was used, by lighting stoves between decks and scrubbing the decks themselves with hot sand, to insure the most thorough dryness." He had learned "how to do it." When in command of the Recruit, off Vera Cruz, he lost no men, while the other ships anchored around him lost from twenty to fifty each, and constant communication was kept up, and all were exposed to the same climatic influences. Not a case of sickness even occurred on his ship. Where he said "*dryness of the ship*," read *dryness of the house*, and one great secret of household sanitation is learned. When the first emigrant ships went to Australia, one third of the passengers died and were buried in the sea; but, through the force of sanitation applied because the shippers were compelled to alter their terms, and were paid for those landed alive, the death-rate was soon made smaller than when the same persons were living ashore.

Through the experience gained in the Crimean War, and largely under the inspiration of Miss Nightingale, a systematic application of better methods began to be made, in the hope of diminishing the awful mortality in the Indian army, and the English were not slow to appropriate the garnered wisdom of other countries. In 1858 public attention was directed to what had been called the "British Juggernaut in India." It was shown that without war or famine a regiment of a thousand men dissolved away at the rate of one hundred and twenty-five a year, so that in eight years not a man of the original thousand remained. A sanitary commission was appointed, and they investigated among other things a series of distinguished preventive sanitary works, in the town of Bonfaric, in Algeria. It was found that the death-rates had been reduced among the military from eighty to thirteen in the thousand; while the children, of whom it had been believed, as in India, that a third generation could not be raised, on account of the deadly nature of the climate, were as healthy as those in the most healthy towns of France.

Of course, sanitation under military authority can be very efficiently carried out, and every fruitful idea, whether from France or America, was acted on, with the result of reducing the death-rate for the decade preceding 1878 to less than twenty in the Indian army and twelve in the home army. In the entire British army—home, colonial, and Indian—the saving of lives in the decade under consideration was more than forty thousand.

Another great source of the lengthening of life is found in the steady advance in temperance. The ardent advocates of total abstinence may imagine this an unfounded claim, but there is not only a lessened consumption of intoxicants, but public sentiment has experienced a complete revolution since the first commission to inquire into the possibilities of improvement was appointed. The "six-bottle" and even the "one-bottle" man have gone out of fashion, and wise Christian philanthropists have learned that some bright, attractive coffee-room, or some other thing that meets the longing for social cheer, must take the place of "Joe's cozy corner," or the gin-palace. Education is beginning to tell in the same direction, and anon there will be found interesting and elevating employment for men's idle hours to complete the cure. In England the opening of the museums and galleries and other places of intellectual culture on Sundays has been found to greatly wean men and women from the gin-palace and "public."

The sanitation of schools and the wiser care of infancy and childhood save annually thousands of "innocents." In the city of New York a man who has long been on the summer corps of extra doctors for the poor says that the very poor are becoming "educated up" by the distribution of leaflets and oral instruction till they really give more intelligent care to their children than the artisan class who hire their own doctors, and, being thought to know all they need to, are often left in dense ignorance.

Few reflect on the saving of life through well-lighted streets and a well-organized police. In Queen Elizabeth's time, John Graunt, who studied the records of crime, boasts that not more than one in two thousand was murdered annually, because the guard of the city (London) was taken in turn by the citizens. At that rate the number of murders for the whole of the metropolis would be twenty-five hundred now, while the actual annual average is no more than twelve in the five million people guarded by the London police—a population almost equal to the whole of England and Wales in Elizabeth's time. No wonder that Hobbes wrote at that time of the life of man as "poor, nasty, brutish, and short"; and, although not all the reasons have been marshaled, it is equally no wonder that the thoughtful are beginning to protest against the literal meaning of "the days of our years are threescore years and ten."

NATURE takes notice of a quaint custom, dating back to Anglo-Saxon times, known as payment of "wrath silver," which was observed last year at Knightlow Hill, a tumulus between Rugby and Coventry, England. It consists of tribute payable by certain parishes in Warwickshire to the Duke of Buccleugh. The silver has to be deposited at daybreak in a hollow stone by representatives of the parishes, under penalty of the forfeiture of a white bull with a red nose and ears. The representatives afterward dined together at the duke's expense.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

V. THE MANUFACTURE OF WOOL.

By S. N. DEXTER NORTH.

I REMEMBER the interest inspired in boyhood days by a certain colored map in a curious and recondite book in my father's library. This map undertook to group the ancient world into divisions according to the raw materials principally utilized in the clothing of the people. As a boy I was impressed by the fact that the sheep's-wool and goat's-hair countries, marked on the map in red, comprised nearly the whole of its space in a broad belt running from Hispania and Gaul on the west, covering the greater portion of what is now Germany and Austria, all of Italy, much of Russia, European and Asiatic Turkey, Arabia, and Persia. The northeast corner, occupied by the vast *terra incognita* of the ancients which we now call China, was marked on the map as the only part of the globe whose people dressed in silk fabrics. Egypt was christened the home of the ancient linen manufacture, and the map was colored in a manner to indicate that flax was also indigenous in several other small sections, mostly contiguous to the upper Rhine, and all of it bordering on rivers. India stood alone, the solitary country whose primitive inhabitants possessed and utilized the priceless inheritance of cotton. The great regions north of the wool belt were vaguely outlined on the map as peopled by barbarians who clothed themselves in skins, furs, and felts, and to whom the art of weaving was presumably unknown. One fond of the contrasts of history could not fail to be struck by the fact that the British Isles, now the home of the textile industries, were included by the map-maker in this vast expanse of country where the wheel and the distaff added nothing to the comforts of life.

If we were now to construct another map on the same principle, we should find the vivid colors which stood for the several fibers on the old map so blended and run together through the great belt line of the temperate zones that neither fiber would here predominate over any other. To-day all the fibers known to the ancients are used by all the civilized people of the globe, each for the purpose for which it is found to be best adapted. Each has had an evolution peculiar to itself, and each has been the gainer by every discovery or invention that has simplified the manipulation and thus extended the use of the other.

The sheep was the first animal which man learned to domesticate for his own service, and none has proved more useful to him.

The whole object of primitive living may be said to have been compassed in the domestication of the sheep. His pelt and wool were the covering for man's nakedness, and his flesh was his food. Thus the sheep was the most important of all the instrumentalities which contributed to the evolution of the primitive man, by slow, uncertain steps, from a state of barbarism akin to that of the beasts, into the first dawn of civilization. The evolution has been accompanied by a scientific attention to the breeding of the sheep, with a view to increasing its wool-bearing powers and improving the quality of the fiber, not surpassed, if indeed it has been equaled, in the care or training of any other animal, and achieving results commensurate with the effort. The history of this evolution is hardly less interesting than that of the manufacture itself.

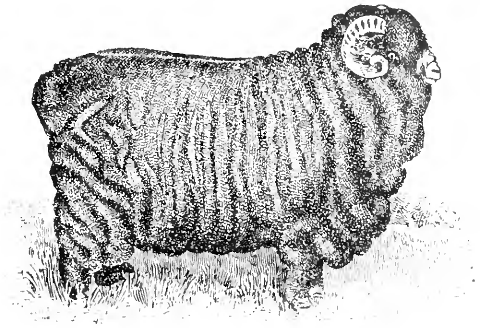

Fig. 1.—A Merino Ram. Weight, 192 pounds; weight of fleece, 35 pounds.

Wool is the only fiber which possesses the felting property in any considerable degree. This quality of felting imparts to woolen fabrics a firmness, an elasticity, a strength, a warmth, and a durability altogether lacking in the products of any other fiber. There is no fiber used in textile manufacturing which has an affinity for dye equal to that of wool. Aniline colors may be fixed on this material by simply bringing the fibers into contact with the liquid containing the coloring matter. Where richness of effect is desired, and a fabric sought which shall possess all the characteristics of artistic development, wool remains, as in the days of the lost effulgent royal purple, the unrivaled material of the artisan. From the pedestal of supremacy where these characteristics placed it wool can never be dethroned.

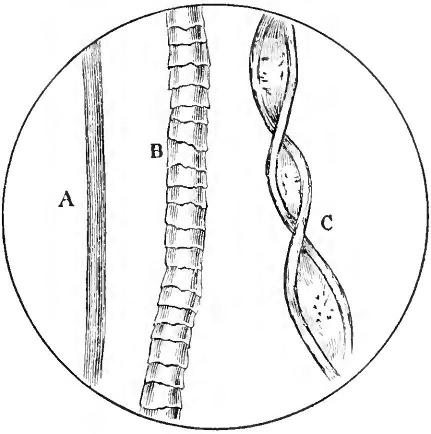

Fig. 2.—Magnified Fibers of (A) Silk, (B) Wool), and (C) Cotton.

Again, the manufacture of wool is the most laborious, the most intricate, the most delicate, the most variable, of any of the fibers; and for this reason among others it deserves to rank, as it does, as the textile industry requiring the most brains and demanding the largest resources of art and skill. The intricacies of its manipulation are unending. They commence with the purchase of the wool itself. The variations of the fiber in quality and character and condition are almost infinite. Particular fabrics can only be produced from particular wools. The successful blending of the fiber preliminary to manufacture is an art in itself. Both the dye-house and the loom-room are schools of art, where the successful manufacturer must feel the pulse of the popular taste, and learn to minister to its whims and caprices. His weaves must change, his patterns must be varied, his coloring must be in good taste, his finish must be perfect. The broadest education in mechanics, in chemistry, in art, is necessary to the perfectly equipped woolen manufacturer.

Prior to the spinning and weaving, and undoubtedly the first artificial clothing worn by man, was the felted cloth, which originated in Asia, the cradle of the human race. Those primeval men discovered and utilized the felting property of wool—that singular peculiarity which distinguishes it from all other fibers—but without the slightest understanding of the philosophy of the property or the causes which led to it. It was not, indeed, until 1853 that the explanation of this property was revealed. In that year William Youatt, to whose investigations we owe our first real knowledge of the character of wool, discovered by the microscope that the roughness and friction of the fiber, when rubbed by the fingers in the reverse direction of its growth, were due to an indefinite number of imbricated rings, or scales, around the stem of the fiber. He detected as many as twenty-four hundred of these scales, or serrations, to an inch of fiber, and the number has since been found to reach as high as four thousand in some instances of fine Saxony wools. It is a suggestive illustration of the crab-like methods of human progress that the first utilization of wool should have grown out of a property the nature of which remained unknown down to the last generation of manufacturing.

An illustration of the intimacy of the most modern and most ancient of civilizations is found in the fact that it was left for an American citizen to first successfully essay the mechanical fabrication of felted cloths. Thomas Robinson Williams, of South Kingston, R. I., invented the process of making felted cloths of commercial length, and patented it May 22, 1830.* Since that day felts have appeared in innumerable forms—as printed

* An earlier American patent, dated October 19, 1807, was obtained by Joseph Pitkins and Timothy Kimball, hat-makers, of East Hartford, Conn., which not only covered machinery for planking hats, but "for making cloth without yarn."

and embossed piano-cloths, ladies' skirts, floor coverings, often with highly artistic designs, material for roofs and protectors against weather, piano-hammers, shoe-linings, etc. It is difficult to imagine any department of industry in which wool, in its felted form, does not somewhere play its part. Thus we have taken the simple discovery of antiquity and made it among the chief instrumentalities of civilization. The Tartars and kindred peoples who occupy the middle and northern regions of Asia, and whose manners and customs have remained unchanged from the most remote antiquity, employ the felted wool in a variety of functions, only less important than the supplying of foods. Both their clothing and their habitations have consisted of felt since a knowledge of them first went upon record in the fourth century. The process of felting was generally known among ancient nations. The Greeks gave to it the name πίλησις, from πιλέω, to compress; literally, a compression, or thickening, of the wool. The ancients employed felt for a great variety of uses, just as we do, the chief being to make coverings for the head, the most common form among the Greeks and Romans being the skull-cap.

When and where and how the discovery was made that the fiber of wool could be drawn and twisted into a thread, which in turn could be woven into a cloth, can not be told. The process devised at the dawn of civilization remains to the present day, viz., the producing of a long, continuous thread from the short fiber, and then weaving these threads into a compact network. The honor of the original discovery was claimed by all the nations of pre-Christian civilization, and probably belonged exclusively to none.

The distaff and loom must have had contemporary origin in different countries, for they were equally utilized, with little variation in form, in the spinning and weaving of wool, silk, linen, and cotton. Always it was the occupation of the women, and generally a domestic operation; although there are evidences that the factory system, so far from being a modern institution, existed three thousand years ago in Egypt, where many women spun in one building together. One of the discoveries at Pompeii is a veritable woolen factory, containing various machines for carding and weaving wool.

Spinning was the occupation of the lowly and the high born alike. Among the pastoral nations the men tended the flocks, while the women spun the wool. This arrangement of the domestic economy of the ancients has found its parallel in all countries and all ages.

The peasant's wife and daughters made their own homespun, and ladies of royal rank occupied their leisure in the fabrication of the garments with which they adorned their persons. Golden and ivory distaffs, highly jeweled, are described by classic writers, and no theme more frequently inspired the poet than the skill and graceful movement of the beautiful spinners.

This occupation of the women continued down to the advent of the modern factory system, which has done more than all else to change the aspects of domestic life. The modern factory-girl has superseded queens and princesses in the manipulation of the fleece, and the whir of machinery and the grime of the factory town have robbed the poet of his inspiration.

The ancient distaff was generally about three feet long, commonly a stick or reed, and held under the left arm. The fibers of wool were drawn out from the projecting ball, and at the same time spirally twisted by the thumb and forefinger of the right hand. The thread so produced was wound upon the spindle until the quantity was as great as it would carry. The spindle itself, made of some light wood or reed, was generally from eight to ten inches in length. At its top was a slit or catch, to which the thread was fixed, so that the weight of the spindle might carry the thread to the ground as fast as finished. The process of primitive spinning is described by Catullus:

Fig. 3.—Ancient Distaff Spinners. (From Montfaucon.)

"The loaded distaff, in the left hand placed,
With spongy coils of snow-white wool was graced;
From these the right hand lengthening fibers drew,
Which into thread 'neath nimble fingers grew.
At intervals a gentle touch was given
By which the twirling whorl was onward driven;
Then, when the sinking spindle reached the ground,
The recent thread around its spire was wound,
Until the clasp within its nipping cleft
Held fast the newly finished length of weft."

These rhymes describe the whole process of spinning the various yarns out of which the clothing of the people was made before the Christian era and for centuries later.

Illustrations are given of the distaff and spindle of ancient Egypt, taken thence to Greece, Rome, Padua, Miletus, referred to

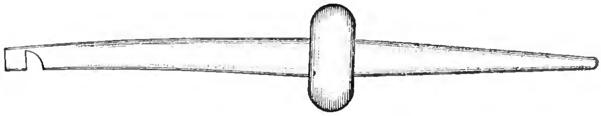

FIG. 4.—A PRIMITIVE SPINDLE.

so frequently in the Scriptures, and still used in parts of India and elsewhere. For at least thirty centuries no other means of spinning was employed.

The Egyptians wove in an upright loom, beginning at the top and weaving downward, so as to sit at their work. In Palestine the loom was also upright, but the weaver, weaving upward, was obliged to stand. There was also a horizontal loom of very ancient date, the earliest known of which was sold in London, together with some "staves," "shuttles," and a "stay," in 1316.

Just what the primitive hand-loom was we know to exactness, for there are still countries in which it is used, particularly in the manufacture of carpets, precisely as it was used before the Christian era. Ouskak, the seat of the Smyrna carpet industry, where five hundred looms are kept busy, illustrates the strength of tradition in resisting innovation as well perhaps as any locality in the world. Here to-day may be seen the female population of the town busily at work, sitting crosswise at the foot of their looms, often as many as ten in a row, each working at a two-foot width of carpet. Their looms consist of two thick poles fixed firmly in the ground; two others are joined, one above and one below, and to these the warp or chain of the carpet is fastened. The yarn is taken from bobbins suspended above their heads and tied to the warp. It is then cut with a sharp knife and the pile and woof driven together by means of a comb.

This primitive method of manufacture has the advantage of permitting a looser texture than is possible where power is used, and in consequence the colors blend more readily and beautifully, and the carpet is soft and pliant to the tread.

The Romans carried the art of wool manufacture to the highest point of perfection that it reached in ancient times. They bestowed the utmost pains upon the improvement of their breeds of sheep, and the fleeces of their finer animals sold for fabulous prices. Woolen garments formed almost the exclusive attire of the Romans, male and female, of every rank, and the enormous supplies of clothing sent to their armies prove that the manufacture must have afforded occupation to large masses of the people. Pliny's

Natural History supplies many clews to the character of the fabrics woven and worn by these chiefs among the wool manufacturers of antiquity. The excellence and variety of the fabrics they made were wonderful in view of their simple tools. The almost infinite variety of forms and textures of fabrics now familiar are simply variations of typical fabrics which these people—as great in the arts of peace as they were great in war—invented or adapted from other nations.

In the twelfth and thirteenth centuries, Florence, Venice, Pisa, and Genoa were the seats of vast wool manufactures conducted on a system somewhat akin to the modern factory system and forming the basis of the great commerce which built up those cities and made them the centers of a wealth, culture, and magnificence which modern times may rival but not surpass. Florence had attained such pre-eminence in the wool manufacture that in 1340 it had more than two hundred establishments, making annually more than eighty thousand pieces, and employing in their production thirty thousand persons. At Genoa were made all descriptions of carded and combed fabrics. The wool industry is forever associated with the discovery of the American continent, for the father of Christopher Columbus was a woolcomber at Genoa; and the great discoverer himself, in the intervals of his schooling, assisted his father in the preparation of the fleece for the spindle. From the Italian cities came the woolen cloths which for centuries clothed the world with which they traded. Thence the wool manufacture gravitated to the Netherlands, and from Flanders, its chief seat there, it spread to all the great manufacturing nations of Christendom.

During the middle ages the working of wool was conducted by small groups of special workmen in various French cities, Paris, Tours, Arras, in the gynecia of the princes and dukes, and especially in the interior and dependencies of the monasteries. In Monteil's History of the French in Different Periods is given a description of the manner of working wool in a French convent in the fourteenth century, which is worth quoting for the light it throws upon the process of manipulating wool before and at the time of Columbus's discovery, and as illustrating the similarity in methods between that time and the present: "Let us examine what operations wools of the abbey farm must undergo from the moment the sheep are sheared, up to the moment when they are placed upon the shoulders of the respectable dames of the convent. I shall first carry the wools to the boilers to get out the grease and wash them; afterward I shall spread them on the drier; as soon as they are dry I shall beat them up; and I shall sort them, and divide them into two lots. On one side I shall put the long wools, suitable for the warp; on the other, the short wools, suitable for the filling. I shall afterward oil the wools for the warp with hog's lard or butter; after which I shall comb them; and, since now the king finds it best that we should card the wool for the filling, I shall card them. I shall have the first spun on the distaff, and the last only on the spinning-wheel. I shall put two harnesses on the loom, for stuffs with a simple web, like cloth, and three or four harnesses for twilled stuffs, according to the kind or quality of the cloth, sometimes fourteen hundred, sometimes eighteen hundred yarns of warp. I shall full the cloths in the mill, to cleanse and felt them. I shall give them a turn of the teasles, to draw out the hair from the wool. I shall full them again, and sometimes I shall sulphur them; sometimes, also, I shall shear them with the big shears. I shall give them a light turn of the teasles when they want my cloths all ready finished. I shall repeat these operations once or twice; and, finally, if I don't want to leave my cloths in the white, I shall carry them to the dyer; if not, I shall press and colander them." The operations here quaintly described remain the same, in principle, as five centuries ago. Only the means of attaining identical results have been profoundly modified.

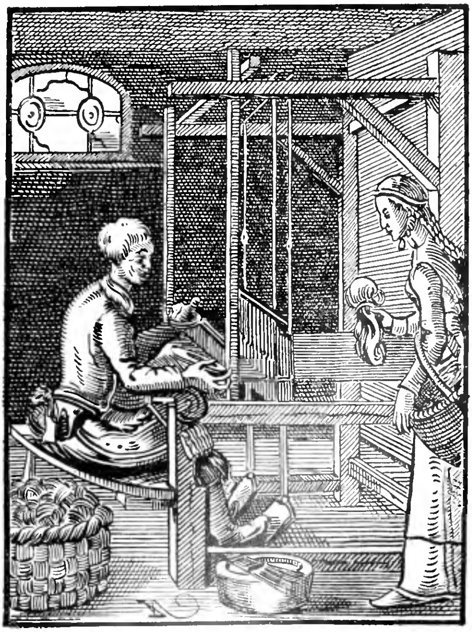

Fig. 5.—Hand-weaver. (From Schopfer's Panoplia, 1568.)

Outside the Low Countries, the wool manufacture had made little progress on the Continent, at the time of the discovery of America. The industry received its first great impulse in France near the close of the sixteenth century. The Edict of Nantes restored to that country the scattered merchants and workmen of the Protestant faith. They brought from the Low Countries, where they had wandered, the arts of spinning, weaving, and dyeing woolens, and founded the first establishments for making woolen cloths. The infant industries were finally planted in their present flourishing seats by Colbert, the illustrious minister of Louis XIV. Seductive offers attracted skilled artisans to her towns. The foundations were laid for the splendid industries of Elbeuf, Sedan, Rheims, and Roubaix; and the French rapidly came to excel all the rest of Europe in the finish, coloring, and softness of their superfine cloths.

Great Britain, famous for her wool for so many centuries during which it was her chief source of national wealth, long remained dependent upon the Continent for the great bulk of her supply of the fabrics—especially the finer qualities—of which her wools formed the raw material. When Julius Cæsar invaded England he found the inhabitants of the southern portion of the island well acquainted with the spinning and weaving of both flax and wool. Wherever the Romans went they carried their arts and their manufactures with them. They were at great pains to send their best artificers to the island, forming them into colleges or guilds, endowing them with certain privileges, and placing them under the great office of the empire, the Court of Sacred Largesses. The first woolen factory was established by them at Winchester, about one hundred years after the conquest of the island, to make the clothing of their army of occupation; but, on the departure of the Romans, the woolen manufacture became practically extinct again.

There is scant evidence of any revival of the woolen manufacture in England until the time of Edward III. Early in the fourteenth century the English are spoken of contemptuously as "only shepherds and wool merchants," dependent for their clothing upon the Netherlands, the only wool weavers in Europe; but even at this time (reign of James I) wool was said to constitute nine tenths of the national wealth of England. Wool was styled "the flower and strength, the revenue and blood of England"; and from time immemorial the lord high chancellor has presided over the House of Lords on a wool-sack, which gave its name to his office, the emblem of the close association existing between the kingdom and its leading industry. Edward III, in the fourteenth century, began the systematic encouragement of the woolen industry. He attracted to England many Flemish families skilled in the art of fabricating wool, investing them with privileges and immunities beyond those of his native subjects.

The king who was wise enough to import citizens to teach his people a new art, sought also to foster its development by restrictive legislation. The exportation of English wool was forbidden, the importation of foreign cloth made illegal, no subject was permitted to wear any clothing save that of native manufacture, and finally a tax of twenty shillings a sack was imposed upon all wool entering into the home manufacture; for this shrewd king did not propose to neglect his own treasury while laying the foundations of new wealth for his people. These laws were the beginning of a series of protective and restrictive statutes in Great Britain, relating to wool and its manufacture, which extended over a period of nearly five centuries. Sometimes this legislation was wise and beneficial; at others it hampered, by almost incredible restrictions, both the growing and the manufacturing interests. A curious study of the relations of legislation to industrial enterprise is offered by the experience of England on this subject.

The development of the industry was certainly very rapid at the commencement of this policy. At the beginning of the reign of Edward III more than half of the cloth worn in England was imported; and, in his twenty-eighth year, it is stated that the exports of cloth were threefold the imports. From that time the progress of the industry was steady, if not rapid; for in England, as everywhere else, until toward the close of the eighteenth century, the manufacture remained a hand operation, and, therefore, essentially the same operation as throughout the middle ages. Some improvements in hand-spinning and in the hand-looms were made, but they were not of a kind that radically changed processes or notably facilitated production. The advance consisted largely in the modification of patterns, the introduction of new designs, and the better application of the art of dyeing. With our present knowledge we may indeed wonder how the capacity of this hand-machinery sufficed to supply the clothing of the world. These were centuries of almost constant war, in which great armies were uniformed in wool. Occupation enough there must certainly have been for the weavers, notwithstanding the fact that there are repeated accounts in the contemporary histories of great depressions and constant dispersion of the cloth manufacture. They were nimble-fingered experts, and could perform feats at the loom which would astonish a modern-day weaver. Some of the fabrics they wove, specimens of which remain to us, were marvels of ingenuity both in pattern and coloring. We have not greatly gained upon them in any of these respects. But the advantages of machine-made cloth over hand-made are obvious, apart from greater productive capacity. No hand-spinner, however dexterous, can impart absolute uniformity to a yarn. Machinery can accomplish a uniformity so perfect that when the scales will detect the variation of the fraction of an ounce it is attributable to carelessness. For the same reason the spinning of the very light yarns, such as are used in that wonderful creation of French genius, the all-wool dress-goods—yarns as fine as two-eighties or two-nineties—was an impossibility before the application of power to spinning. No human skill, however trained and expert, can throw the shuttle with the precision of power.

The contemporary progress of civilization is shown by the fact that the textile arts were quite as fully developed in America when the existence of another continent was revealed to the Europeans as in Europe itself. Spinning and weaving had been practiced among the ancient people of Peru and Mexico for a period of time which can not be limited by any knowledge we possess, and by practically the same methods which obtained in the nations whose records came within the ken of history centuries earlier.

The Mexicans spun and wove cotton, and the Peruvians both cotton and wool, into fabrics which the Spaniards found in every way equal to anything they had known at home. The Peruvians, in particular, were adepts in the art. When Pizarro made the conquest of their country in 1533, he found in the empire of the Incas four species of animals little different from each other, which he called the sheep of the country (*carneros de la terra*), because of their general resemblance to the Spanish sheep, and the similar utilization of its fiber. Two of the species, the llama and alpaca, had been in a state of domestication from time immemorial, the remaining varieties, the vicuna and the guanaca, living in a wild state in the fastnesses of the Andes. From a variety of sources we are able to obtain minute details of the importance which the Government attached to these animals, and the large part which they played in the domestic economy of the country.

The Peruvian woolen fabrics were of three kinds—a coarse woolen cloth, which they called *avasca*, which formed the raiment of the common people; a finer variety, called *compi*, worn by the captains and officials; and still another, also called *compi*, but of much finer quality, reserved for the use of persons of royal blood. Specimens of this cloth, still preserved, reveal a fineness of texture and an exquisite finish which modern ingenuity rarely equals. Both sides of these cloths were woven alike. The delicacy of the texture gave it the luster of silk, while the brilliancy of the dyes employed excited the envy and admiration of the European artisan. The Peruvians made also shawls, robes, carpets, coverlets, and hangings in great varieties of patterns. They knew how to produce an article of great strength and durability, by mixing the hair of animals with the fleece of their llamas.

Garcilasso gives a very pretty picture of the domestic life of the Peruvians, which was largely occupied in this manufacture. There was little sewing to be done, according to his accounts, "because the cloths worn both by men and women had few seams. All they wove was first twisted. All the cloths were taken from four selvages. They did not have the warp longer than was required for each woolen shirt. The vestments were not cut out, but were entire, just as the cloth came from the frame, for before they began to weave they settled the required length and breadth, more or less."

That these two civilizations should have existed for centuries on the American continents, with high forms of civilization, including the textile arts, developed in both, but neither in any way springing from the other, or from any European source, is not more surprising than that the rest of the population of the Western hemisphere should have been without these forms of civilization. There exist to-day communities in which the arts of spinning and weaving have never been known, and are still unknown. Wherever civilization is indigenous, there these arts have existed as one of the first evidences of it, and the progress in these fields has everywhere been indicative of the general progress of civilization and the capacity of the people of the several countries to adopt and take advantage of the new sources of wealth and comfort which steam, with the mechanical inventions of which it is parent, places at the disposal of capital and labor. The transformation of the woolen industry, through these agencies, has been complete, as we shall now show.

The Evolution of the Card.

When primitive woman made the first discovery regarding the capacity of the fleece of the sheep to be spun into a yarn, and that yarn to be woven into a cloth, she compassed the whole of the discovery with reference to wool manufacture. All that has since happened has simply been the perfecting and the enlarging of that original discovery. We still spin and we still weave; and the fabrics we make are of no firmer texture or more beautiful design than those which existed in prehistoric times. We have substituted steam for the human hand; we have simplified and multiplied processes and thus increased the variety and the amount of the product and decreased the cost of production. But throughout all the changes in yarn-spinning, the rotary spindle continues to be the essential implement; all the improvements have had for their objects, first, the application of mechanical methods for rotating the spindle; second, automatic methods for attenuating the fibers; and, third, devices for working large groups of spindles simultaneously. Weaving has always been done by warp yarns, or threads, running longitudinally, and weft or intersecting yarns thrown at right angles across the warp by hand, by hand-shuttle, or by power-shuttle. Invention seems, at first sight, to have carried the automatic principle as far as it can go, in both operations, and in all the preliminary and subsequent processes. But a study of the steps of this evolution will convince us that past inventions, so far from diminishing the field for the exercise of the human mind in the woolen manufacture, have greatly increased it.

The evolution of the wool manufacture has not succeeded in reducing the number of the processes through which the wool must pass in its long journey from the back of the sheep to the back of man. It has only expedited and simplified them. When Dr. Ure exploited the philosophy of manufactures in 1835 he gave a list of the operatives whose separate manipulations were necessary to the woolen manufacture—twenty-four in all. The list is remarkable alike for its length and for its nomenclature—it being plain how words were coined, out of the nature of the occupation, to meet each case. In tracing the evolution of the manufacture, it is well to have this list before us:

Fig. 6.—Ladies Carding and Spinning Wool. (From a fourteenth-century MS. in the British Museum.)

"Wool-sorters, pickers, willyers (winnowers), carders, scribblers, pieceners, slubbers, spinners, warpers, sizers, weavers, scourers, dyers, burlers, fullers, boilers, giggers, driers, croppers, singers, glossers, pressers, brushers, and steamers."

Each of these names stood for a distinct process in the manufacture through which the fiber must pass before it was converted into cloth. Many of them are now known by different names, but all of them represented successive steps in the manufacture, some of which are now combined, but all of which are still necessary, and all of which, except the first, are now performed automatically, by a great variety of machines, bewildering in their number, complicated in their movement, and representing a body of inventions, as applied to all the textile industries with the necessary variations, which finds no parallel in any other of the human arts. Each of these processes was by hand up to about the middle of the last century.

It will be necessary to confine our attention in this paper to the historical development of the main processes of the manufacture—the carding, the combing, the spinning, the weaving, and the finishing—the processes in which the mechanical advance has been fundamental. The various machines which now expedite the supplementary processes have grown out of the inventions which have attended these fundamental processes, and they are of special interest only to those practically engaged in the manufacture. Their invention has been suggested—in fact, compelled—by improvements in the primary machinery. We shall be struck, as we proceed, with the dependence of each forward step in this evolution upon some preceding advance, one invention making possible others, which without it would not have been dreamed of.

The wool comes into the mill dirty, greasy, burry, sometimes washed by the farmer, but generally just as it is sheared from the sheep, a filthy and unwholesome thing, giving little sign of the beautiful white and flossy substance into which it is soon converted. It must first be sorted, each fleece containing from six to eight qualities of sorts, which the careful manufacturer separates, devoting each quality to the purpose for which it is best suited. No skill in carding, spinning, weaving, or finishing, can possibly produce a soft or fine piece of goods from a coarse, hard fiber. When a woolen thread is to be spun to the length of 15,360 yards to a pound, or in the case of a worsted thread to twice that number of yards to a pound, everything depends upon care in the selection of the fleece and in the sorting. These sorts are impregnated with a greasy substance called the yolk or suint, caused by the animal secretions and the perspiration of the skin, a compound of potash and animal fat, which must be completely eradicated. The elimination of the yolk, dirt, and foreign substances, common to all wools, results in a shrinkage of from fifty to seventy per cent.

Our ancestors scoured their wool in tubs, much as our wives and daughters scour our clothes to-day. In the hand-washing of wool, a tub was filled with the suds, in which one or two men with long poles stirred the wool until clean, when they lifted it upon a traveling apron, which carried it between a pair of rollers which squeezed out the water. The same principle is applied in the automatic scouring now in vogue. Great forks or rakes seize the wool as it is carried by rollers from a feeding apron into the iron tanks, and by alternating motions of their teeth give it a thorough scouring. Thus cleansed, the wool is delivered by rollers to the drying machines, where hot air and great fans are now utilized to extract all the moisture without tearing the fiber. The ventilation—drying of wool by means of hot air—effects the object in one tenth of the time occupied by the old method of drying by exposure in the open air. So enormous has been the increase in the production of wool, stimulated in all quarters of the globe by the enlarged capacity for its manufacture; so different are the quality and characteristics of these wools, collected from all countries and grown under all conditions; so illy prepared is much of it for manufacture, that the art of the manufacturer is now largely shown in the skill and care with which he selects, sorts, mixes, prepares, and treats his raw material, the processes preliminary to its carding. Potash, carbonate of soda, silicate of soda, ammonia, and soap are all more or less used in wool-scouring. So delicate is the fiber that the ingredients employed must be most carefully considered. The character of the water used is often an element which affects the fiber throughout its manipulation. Chemical science has done much to aid the manufacturer in this branch of his work. Invention has also provided steeping machines, to drive off the acid contained in the fibers, and dissolve the hard, dirty substances, without removing the yolk, which is valuable as a detergent. A preliminary machine is sometimes used to eliminate the troublesome burr, often imbedded in the fleece, and other vegetable substances which, unless wholly removed, destroy the fine finish of the goods. The use of chemical agents in the process of extracting vegetable matter, supplementing this machinery, is also a modern discovery, requiring the utmost skill and care in application to leave the fiber itself uninjured. Wool being the only substance which has absolute need to be oiled in order to be spun, this step in the manufacture occurs at the blending—that is, the mixing of the different sorts, or the cotton and shoddy—if either of these adulterants is used prior to the carding.

Fig. 7.—Ladies Carding, Spinning, and Weaving. (From a fifteenth-century MS.)

So long as spinning continued to be done on the one-thread wheel, there was no need for expediting processes in the preliminary preparation of the wool. The carding of the fleece could be done by hand, as fast as the spinners could dispose of it. Carding was done at the time of Columbus by a pair of hand-cards, which are shown in the illustration from a fifteenth-century manuscript. These cards were simply rough brushes, armed with fine wire teeth set in leather, by which the fibers of the wool were reduced from their matted condition into a form somewhat parallel, to facilitate the spinning. With two of these brushes the operator, by repeatedly stroking one brush, laden with tufts of wool, against the other, gradually untangled and straightened them. The "cardings" were then taken carefully away from the wire bristles, and condensed into a roll, by rolling them on the back of the card, when they were ready for the spinner. Nothing could have been more primitive than this original card operation.

Some slight improvements of the hand-card preceded the invention of the cylinder machine. A frame adjusted to an inclined plane was equipped with coarse cards, on which the wool was placed. Sitting in front of this frame, the workman held in his hand a square board, also covered with cards, and carded the wool with a seesaw motion over the inclined plane. Daniel Bourne took out a patent for a carding machine in 1748, in which the principle of cylinder carding was rudely hinted at. "The cards are placed on cylinders or rollers," said his specifications, "and these act against each other by a circular motion."

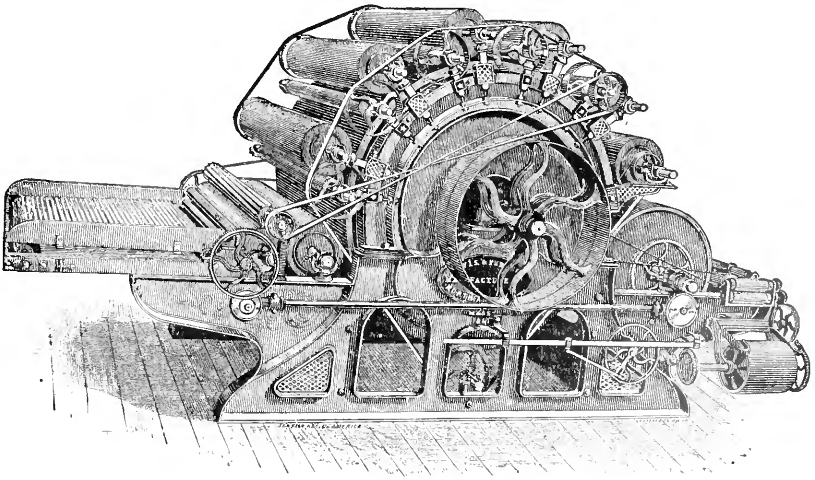

Fig. 8.—An American Carding Machine—First Breaker.

This was the main principle of carding as now practiced. Improvements upon Bourne's machine followed rapidly. William Pennington and Robert Peel made modifications which led the way to Arkwright's "doffer comb," patented in 1775. To Arkwright also belongs the credit of the invention of the workers and strippers.

The present carding engine was evolved by successive steps at long intervals. The most important contribution to the card-wool industry during the present century was the invention of John Goulding, of Worcester, Mass., and was patented in 1826. Before his invention the length of the rolls issuing from the carding machine was limited to the breadth of the card. The ends of the separate rolls had to be spliced together by hand, a tedious and expensive process, with the aid of a machine known as the billy. Goulding dispensed with the billy altogether, and accomplished with four machines what had previously required the use of five. The invention enabled manufacturers to produce yarn from wool at much less cost, of better quality, and in greater quantity than was produced by the old process. His machine also dispensed with short rolls and introduced the long or endless roll. Goulding's invention thus combined in the carding process operations which up to its introduction required an intermediate process before spinning to prepare the roving for the jack. The purpose of this superseded machine, called the billy or slubbing machine, was to join the detached rovings in a continuous spongy cord, to which it also imparted a slight twist and some draft. This operation had been performed in the days of hand manufacture on a spinning-wheel somewhat similar to the common spinning-wheel but smaller in size. The slubbing billy was introduced soon after Hargreaves's invention of the spinning jenny had been applied to the woolen manufacture, and closely resembled this machine in its working parts.

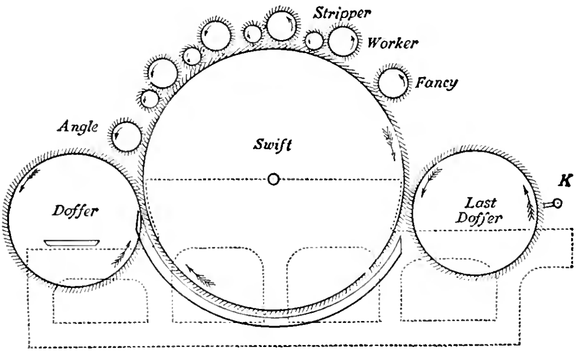

Fig. 9.—Working Parts of a Carding Machine.

The cardings, as they fell from the card machine, were taken up by children, called pieceners, whose work it was to join these porous rolls by rolling their ends together with the palms of the hand, and then lay them upon the billy board, whence they were drawn upon the spindles by the movement of a carriage and wound into a conical cop. The billy usually contained from fifty to one hundred spindles, and its wheel was turned by the slubber, who must also draw the carriage. One slubber and one billy were appointed to each carding machine, and generally four pieceners. It was in this branch of the work that complaints of cruelty to children were so frequent during the earlier half of the century. It was well established in parliamentary investigations that the slubbers frequently maltreated the children they employed. It was not until 1826, as we have seen, that the invention of Goulding, by making automatic roving possible, dispensed with the labor of children in this branch. Goulding's invention was as large a gain to humanity as to the manufacture.

Until recent years, the raw material was fed upon the cards by hand. Before the invention of feed rolls and endless apron, the wool was held in the hand against the revolving surface of the card-roller until it was seized by its teeth. Then a "feed-sheet" of cotton cloth was invented; then the lattice-apron. By both these devices the wool was taken from the feed-roll directly by the main cylinder of the card. Then came the "tumbler," interposed between the feed-rolls and the cylinder; then the wooden "licker-in" was added, and years later the metallic burr-roller, invented by Francis Alton Calvert. In 1864 a Belgian inventor, Jean Sebastian Bolette, invented a machine which measured the wool as it fed the card, and regulated the supply automatically. Still another machine, the work of an American inventor, William Calvert Bramwell, mixes as well as weighs the wool, throws out much of the remaining refuse, and permits a carding machine to turn out from twenty-five to forty per cent more work than was possible by hand-feeding. These automatic feeders, and additional series of equally ingenious machines for transferring the wool from one card to the other, and the improvement of the card itself, have enormously increased its productive capacity. Fifty pounds of clean wool a day was a very fair average for the carding engine of twenty-five years ago. This average has now increased to one hundred and one hundred and fifty pounds a day, according to the width of the carding machine and its cylinders, and the quality and character of the materials employed.

It is astonishing to watch these monster engines, grim as implements of war and death, absorb the tangled wool in their greedy jaws, draw it tenderly upon their bewildering mass of rapidly revolving wheels, cylinders, and rollers armed with sharp teeth, shake from it any remaining dirt or foreign substance, whirl it rapidly round and round and in and out, and finally deliver it in the form of a dainty, white film, which another attachment gathers automatically into balls or rolls, ready for the preliminary processes of spinning.

Modern carding accomplishes four things essential to successful manufacture: the thorough blending of the component fibers; their rearrangement in a form somewhat parallel; their final cleansing of all refuse matter; and their union and condensation into a continuous thread called the sliver. To accomplish these ends with the utmost speed, with a minimum of waste, without injury to the delicate fiber, is the function of the modern carding machines. In a general way the process is that of carding cotton, but the resemblance is only general. Between the carding machinery and the loom, in the wool manufacture proper, there is now but one machine, the mule or frame; but in the manipulation of cotton there are several machines between card and loom, and the doublings amount to thousands. Thus the carding process in the woolen manufacture is the most important of all in one sense, instead of the spinning, as in cotton manufacture.

There are two systems of carding now in common use. That most generally adopted in the woolen manufacture in England consists of a scribbler, containing two swifts, an intermediate, also with two swifts, and a carder, containing two swifts and a condenser. The system universally in vogue in this country in the woolen manufacture has the same set of three machines (called here the first breaker, the second breaker, and the finisher), but each engine having but one swift or large cylinder, as in the illustration here given. Both systems produce satisfactory results. Each of these three machines is nearly similar, and each advances the material from the other. The main organ of a card is the cylinder, generally about four feet in diameter, and covered with card clothing, not different in principle from the primitive clothing above described. Around this cylinder revolve several smaller cylinders, similarly clothed, called workers, which continually remove the wool from the main cylinder, separating the fibers and combing them. From the workers, as they become saturated with wool, it is removed by another roll with longer teeth, called the "fancy," which revolves at a higher speed. The carded wool is then removed by the "doffer," and passes on to the second and third machine, to undergo the same process twice more, each time by finer card clothing, until it is finally removed by a pair of small rollers called condensers. These condensers, one above the other, have strips of card clothing affixed, which alternate. Thus the wool is taken off in long strips, which pass through more condensing rollers which are given a transverse rectilinear motion, the combination of these two giving a soft and twisted thread of woolen yarn or sliver.

Some conception of the amount of dislocation and blending of fibers to which these carding engines subject the wool is possible from the fact that there are upward of fifty-six million teeth or points in an ordinary English card, fifty millions of which come in contact with the wool, separating and carrying it forward, six millions playing the part of extractors, drawing the fibers from the teeth of the other rollers. Prof. Beaumont estimates that, in an ordinary scribbling engine, the wool is continually subjected to the disturbing and intermixing action of twenty-five thousand points. Remembering that this operation is three times performed, we can imagine how complete is the transformation to which the sorts of wool are subjected in the carding process. We can thus readily understand how much more perfect is the carding operation, as now performed by machinery, than anything that was possible under hand manipulation.

QUESTIONS CONCERNING THE MINOR PLANETS.

By M. F. F. TISSERAND, of the Institute of France.

KEPLER, having found a break in the continuity of the mean distances of the planets from the sun, boldly filled it by supposing a new planet between Mars and Jupiter. The publication of Bode's empiric law in 1772 helped confirm the ideas of Kepler, and fixed the distance of the hypothetical planet at 2·8 times that of the earth. A new authority was given to this conclusion after the discovery of Uranus by William Herschel in 1781. The calculations of Lexell and Laplace showed in fact that Uranus's distance might have been furnished in advance, with a near approach to exactness, by Bode's law. At a conference held in Gotha in 1796, Lalande and De Zach proposed to search for the unknown planet, and to divide the labor among twenty-four astronomers, each of whom should examine an hour of the zodiac.

On the first day of this century—that is, January 1, 1801—Piazzi discovered at Palermo a star which he took at first for a little comet and observed several times till the 11th of February following, when illness stopped his work. Bode was the first to recognize that the star could not be a comet, and thought that in Ceres Piazzi had found the planet suspected by Kepler. When Piazzi had become well again, he did not know where to look for Ceres. It was to be sought for toward the end of the year, after coming out from the glare of the sun, but no data were at hand for determining its position except the geocentric arc of 3° which it had traversed during the forty days it had been under observation.

Here Gauss came to the rescue; he was then twenty-four years of age, and had had little or nothing to do with astronomical calculations, having been occupied chiefly with the higher arithmetic. In less than a month he invented an admirable method for calculating the elements of the elliptical orbit of Ceres and an ephemeris, by means of which Olbers found the star again on the first day of January, 1802. The mean distance of Ceres from the sun is 2·77. It corresponds exactly with Bode's law, and fills the gap, but with a very modest planet, having a diameter of only about 200 miles.

Olbers's discovery, on the 28th of March, 1802, of a second planet, Pallas, revolving around the sun at the same mean distance as Ceres, presented the question under a new aspect. Gauss's calculation showed that Ceres and Pallas might, in time, come to pass very near each other on the line of intersection described as A B of the planes of their several orbits. Olbers was thus led to think that the two little bodies might be fragments of a greater planet which had been broken up by an internal commotion. If this were the case, there would probably be other fragments, the orbits of which would pass the line A B, so that by watching the two points A and B, where this line strikes the celestial sphere, chances might occur of seeing the fragments of the primitive planet pass. Eventually Harding found Juno near A in 1804, and Olbers discovered Vesta near B in 1807.

Further researches, carried on by Olbers till 1816, brought no result; and it was not till 1845 that a fifth body, still smaller than the other four, was discovered by Encke. After this time, discoveries became frequent and regular, till now 299 are known.* But the size of the new stars keeps getting smaller: the first four were between the sixth and the eighth magnitudes; the two discovered by Encke were of the ninth; and those which are now discovered from time to time seldom exceed the thirteenth magnitude. William Herschel, in consideration of the small size of these bodies, and hardly regarding them as sufficient to fill the place of a planet, thought it more fitting to call them asteroids than planets.

A survey of the orbits of the asteroids as a whole will help us to gain clearer ideas respecting them, and may bring out a few simple relations that will cast some light on the origin of the bodies. The supposition of Olbers is not sustained. Prof. Newcomb, having studied the orbits of the first forty asteroids, found that, as they move to-day, they are far from passing in the same line. Even the hypothesis that the geometrical condition supposed may once have existed, but has been changed by the perturbations caused by the attractions of the other planets, is contradicted by the calculations.

But this hypothesis, though it must be abandoned, has the credit of having provoked the discovery of Juno and Vesta, and of having suggested Lagrange's theory of the origin of comets, to which M. Faye has added a number of curious speculations, and by the aid of which we may, perhaps, some day find an explanation of the origin of meteors. The smallest mean distance from the sun of the known asteroids, 149, is 2·13 (times the mean distance of the earth); the greatest, that of 279, 4·26; the corre-

* Since increased to 308.

sponding periods of rotation are 3·11 and 8·81 years. They both revolve, therefore, on either hand, outside of the limit, 2·8, assigned by Bode's law. If we take account of the eccentricities, 131 comes within the distance 1·31 from the sun, and 175 goes as far as 4·73 from it. The asteroids, therefore, perform their movements within a very extended zone, and the *ensemble* of their positions forms a kind of ring, the breadth of which is more than three times the distance of the earth from the sun. A comparison of the eccentricities shows a mean of 0·15, much higher than the corresponding mean, 0·86, of the older planets. This, too, indicates that there are notable differences in the conditions of their formation. The difference is still more striking in the inclinations of their orbits. The mean of the inclinations is 8°, a little higher than that of Mercury and that of the equator of the sun. But of two hundred and ninety-three asteroids, there are seventeen that have inclinations higher than 20°. When their mean distances are also considered, these seventeen seem to arrange themselves in two groups, around the distances 2·75 and 3·15 respectively; but this appears to be only because asteroids are more numerous in those two regions. It is also noteworthy that the much inclined orbits are usually also very eccentric, but the converse does not hold. A great eccentricity does not seem to involve of necessity a great inclination.

The question may arise whether the asteroids may not all at first have been placed in orbits of slight eccentricity and slightly inclined to the plane of the ecliptic, and their eccentricities and inclinations then have increased considerably—at least those of some of them—under the influence of perturbations. The researches of Lagrange and Laplace have shown that the eccentricities and inclinations of the old planets could vary under the influence of their mutual attractions only within narrow limits. But this result is established only for determined distances of the planets from the sun. Is it sure in advance for other intermediate positions, and particularly for the space in which the asteroids move? Leverrier asked this question, and made the curious remark on the subject that there exists, between Jupiter and the sun, a region in which, if we place a small mass, in an orbit but little inclined to that of Jupiter, that mass will leave its primary orbit and attain large inclinations to the plane of the orbit of Jupiter and to that of Saturn. It is remarkable that this position is at nearly twice the distance of the earth from the sun—that is, near the interior edge of the zone in which the minor planets are found. This fact, interesting as it is in itself, does not explain the large inclinations that have been determined at the distances 2·15 and 3·15, which are very different from those indicated by Leverrier as those at which a certain amount of inclination may be produced. I made a similar research a few years ago concerning eccentricities, and found a region of instability corresponding with a still smaller distance from the sun, 1·83. The perturbations caused by Jupiter and Saturn must therefore be regarded as insufficient to explain the considerable values of the eccentricities and inclinations of so many asteroids. These values were never small, and consequently the conditions in which Laplace's nebula existed were not the same at the times of the formation of the asteroids as they were when the old planets were fixed. An interesting cosmological question is presented here, and the accumulation of new discoveries of asteroids can only facilitate its solution.

The distribution of the asteroids, according to their mean distances from the sun, or (which amounts to the same thing) according to their mean diurnal motions,* offers some curious facts. A table showing this factor for all the asteroids but three presents the striking feature of accumulations of minor planets about the mean motions 640″, 780″, and 815″, with which correspond the mean distances 3·13, 2·75, and 2·67. Two principal voids may also be recognized, about 600″ and 900″, or the mean distances 3·27 and 2·50 from the sun. The mean diurnal motion of Jupiter is 299·42″ or very nearly 300″. The voids that have been pointed out thus correspond with regions where the mean motion of the planet would be exactly double or triple that of Jupiter. There are other less well-defined voids, in which the relation of the mean motions to that of Jupiter, instead of being 2 or 3, would be represented by one of the fractions $\frac{5}{3}$, $\frac{7}{3}$, $\frac{5}{2}$, and $\frac{7}{2}$. Prof. Kirkwood first brought out this fact in 1866, and generalized it by saying that the parts of the zone of the asteroids in which exists a simple relation of commensurability between the period of revolution of a minor planet and that of Jupiter are represented by gaps like the intervals between the rings of Saturn. We remark in addition that the gaps are less sharply marked than in the case of the rings of Saturn, in that after a void the number of asteroids does not increase suddenly, but gradually, till it regains its normal value.

Can the voids be accounted for by the theory of perturbations? We should have a very simple explanation if we could show that two planets, the durations of whose revolutions are in a simple commensurable relation, exist for that reason in an eminently unstable condition which they are liable to abandon at any moment. If these conditions are realized, the usual theory of perturbations defaults; but we can not conclude that instability would result from it. Recent calculations seem rather to lead to opposite con-

* The mean diurnal motion is the quotient of the division of the number of seconds (1,296,000) in the circumference by the number of days of the planet's revolution.

clusions. Gauss, communicating to Bessel in 1812 the discovery of the ratio of $\frac{7}{18}$ between the mean motions of Pallas and of Jupiter, said that that value ought to be realized more and more exactly under the influence of the attraction of Jupiter, in the same way as the motions of translation and rotation of the moon are equalized. Newcomb has expressed the same opinion, to which he was led by his studies of the system of Saturn, saying that while one would think that, in the case of movements absolutely commensurable, perturbations would not fail to grow beyond limits to the point of compromising the stability of the system, the consequence is not a necessary one; there would probably be only oscillations more or less irregular, but equilibrium would be re-established incessantly. The labors of M. Gyldén and my own personal researches tend to the same conclusion.

It is therefore probable that, if the voids had not existed in the beginning, further perturbations by Jupiter would not have been sufficient to produce them; they without doubt already existed, immediately on the formation of the asteroids, and give another reason for considering the question they present as of primary interest from a cosmogonical point of view. It is of no less interest in the matter of the celestial mechanism, for it corresponds, as we have said, to a case in which the old methods default, and which has instigated the most interesting studies of the period. Laplace has already considered it in his theory of the satellites of Jupiter, but the asteroids present it to us under conditions which make its solution still more difficult.

The minor planets situated at the outer limit of the ring are interesting from several points of view. Some of them furnish a kind of transition between the asteroids and some of the periodical comets. Thus, the orbit of 175 is very like that of Tempel's periodical comet. The distinction between planets and comets, founded on the dissimilarity of their orbits, vanishes here. We have nothing left to distinguish them but their physical aspect. The asteroids of which we are speaking, being near Jupiter, are always very distant from the earth. They must, therefore, appear small in proportion to their dimensions. It is possible that, by seeking with a strong enough glass, we shall find others; and some of these may come in to corroborate the resemblances with the periodical comets. Planet 279, discovered two years ago by M. Palisa, is one of the most remarkable of the group of which we have just spoken. In 1912 it will come with the distance 1 of Jupiter, and will continue there for a considerable time. The attraction of Jupiter will then be more than one fiftieth as great as that of the sun. The calculation of the perturbations promises to be interesting and difficult, and will make it possible to deduce the mass of Jupiter with great precision. The planets at the lower limit of the ring may, in case their orbits are very eccentric, come very near the earth—even within a distance of 0·7—in which case it will be possible to determine their parallax accurately by observing it from two distant stations, as we do the moon. Thence we can deduce the parallax of the sun; and this is one of the best methods within our reach of obtaining this fundamental element in astronomy.

We have said that it is impossible to connect all the asteroids with the rupture of a single planet; but we can form groups of two planets whose orbits present curious resemblances which do not seem due to chance only. The most interesting group is formed of the planets 37 and 66. Their orbits are nearly equal ellipses, situated almost in the same plane, and differing only in the orientation of the major axes. This almost complete identity of four of the five elements, which exists now, and will, according to the calculations, be maintained, can not be accidental. Many facts of this kind will not be needed to illustrate to us the origin and formation of the asteroids. Maia (66) was lost for fifteen years, till it was found again by the help of M. Schulhof's calculations. There are other similar groups, and more will probably be found.

I trust that this notice will show a rich harvest of interesting facts in prospective. To speak only of acquired results, it may be recollected that Gauss composed one of his finest works for the purpose of recovering Ceres. It was in seeking for a quick way of verifying Leverrier's numerical calculations upon the great inequality of Pallas that the illustrious Cauchy wrote admirable memoirs, from which great advantages are now derived for the theories of the older planets and for the most delicate points in the theory of the moon. It would be unjust, too, to forget the excellent labors of Hansen and Gyldén, which had the same origin.

The asteroids have also been the occasion of important advances in observation. The search for them has trained observers of the first order. The purpose of following them with greater facility has led to the construction of powerful instruments, among which is the great meridian circle of the Observatory of Paris. The maps of the heavens and catalogues of stars have through them been made more nearly perfect. Among these the ecliptic maps of MM. Henry deserve special mention. When these astronomers undertook to construct the maps across the milky way they were dismayed by the immensity of the work, and invoked the aid of photography. The remarkable results they obtained have served as the point of departure for the enterprise of the photographic map of the sky. The Astro-Photographic Congress at Paris, in 1887, decided to photograph the whole sky down to stars of the fourteenth magnitude. Could this enterprise have borne all the fruits it has if the planets of the thirteenth magnitude had been let pass unperceived?

For all these reasons, I think that the search for minor planets ought to be continued. It demands, indeed, considerable work in calculation; but that can be divided among several scientific establishments. The Bureau of Longitudes is disposed to do its part in the matter.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE NATCHEZ INDIANS.

By HOWARD A. GIDDINGS.

THE Natchez were the ancient head of the demi-civilized people inhabiting that part of America called Florida by the first discoverers. It is evident, from the historians of De Soto's expedition, that a state of society prevailed among this people very different from that of their neighbors. The Natchez can not properly be classed as North American Indians; differing widely from all other tribes in language, customs, and condition, they seemed in most respects like another race. They came originally from Mexico, and closely resembled the Aztecs, both in appearance and habits. Possessing none of the roving disposition common to the savage, their houses, furniture, and domestic implements were comparatively comfortable and convenient. We are told that their houses were gathered together into towns, and resembled farm-houses in Spain, being surrounded with bake-houses, granaries, etc., showing a nation no longer in the hunter state, but attached to the soil, with all the corresponding effects of a life advanced a step toward civilization.

Their houses were nearly always a perfect square. They constructed them by bringing from the woods young trees about fifteen feet in length and four inches in diameter, which they planted in the ground fifteen inches apart, the strongest at the four corners; the tops being bent inward to the center and fastened with split canes. The chinks in the walls were filled up with a mortar of mud mixed with a tufted herb called Spanish beard, leaving no opening but the door. The roof was thatched with turf and straw, and over all was plaited a mat of split canes; the walls were covered both inside and out with mats of the same material. With occasional repairs these buildings lasted twenty years.

The Natchez lived under a despotic government, and it is but natural that the chiefs were lodged in a manner superior to their subjects. The following description (Garcilaso de la Vega, Historia de la Florida) will apply generally to all the capitals and habitations of the chiefs in Florida:

They always endeavored to place their towns upon elevated sites; but, because such situations are rare in Florida, or on account of difficulty in procuring suitable materials for building, they raised eminences (mounds). Choosing a suitable place, they brought a great quantity of earth, which they raised into a kind of platform, sometimes of a very considerable height, the flat top of which was capable of holding from ten to twenty houses, to lodge the cacique (chief), his family, and suite. The sides of the mound were made so steep that it was impossible to ascend but by steps, or causeways of earth, sloping gradually to the ground. Around the foot they traced a square, conformable to the extent of the town they intended to build, and around this square the more considerable people built their dwellings. The commonalty built around them in the same manner; the whole population thus surrounding their chief.

The house of the cacique was larger and more commodious than the houses of the people, but not otherwise materially different; though a Portuguese gentleman who accompanied De Soto describes the houses of the chiefs in some parts of the present State of Alabama as having had porticoes to their doors.

It is stated that in the dwelling of the Cacique of Palisema the inner apartment was hung with buckskins so well dried and wrought "that one would have taken them for good tapestry, the floor being also covered with the same." The furniture in the dwellings of the Natchez corresponded with their superior construction. They had an equivalent for a bedstead, and also wooden seats or stools, boxes, baskets, and mats of split cane, finely wrought and ornamented.

Their tools, like those of the barbarous tribes, were made of bones, flints, etc., although copper was sometimes used. In the history of De Soto's invasion we read of copper axes or hatchets, pikes with copper heads, staves, clubs, etc., made partly or entirely of copper. They also made "kettles of an extraordinary size, pitchers with small mouths, gallon bottles with long necks, and pots or pitchers for bear oil which would hold forty pints." They made salt from the water of saline springs near the mouth of the Arkansas River, evaporating it in earthen pans made for the purpose, which left the salt formed into square cakes. Their dress was much like that of the ruder tribes, which, however, they surpassed in the manufacture of clothing from wild hemp, mulberry bark, and feathers. McCulloh states that fans made from feathers were used by the Natchez nobility.

They cultivated maize, beans of several kinds, the large sunflower, sweet potatoes, melons, and pumpkins. Bartram found around the ancient monuments of Georgia and Alabama fruit trees, supposed to have been planted by the Natchez. Among them were persimmon, honey locust, Chickasaw plum, mulberry, black walnut, and shell-bark. On one occasion De Soto's troops came upon a pot of honey, "though neither before nor after did they see bees or honey."

The language of the Natchez was easy in pronunciation and expressive in terms—that of the nobles being slightly different from that of the people. For instance, in greeting a noble, one would say "*apapegonaicke*," which is equivalent to "good morning"; while to express the same thing to one of the people, we would say "*tachte-cabanacte*." To request a noble to be seated we would say "*cabam*," while to a common person we would say "*petchi*." The two languages are nearly the same in all other respects, the difference in expression seeming only to take place in matters relating to the persons of the Suns and nobles, in distinction from those of the people.

The Natchez were celebrated for their feasts and festivals. They began their year in the month of March, as was the practice for a long time in Europe, and divided it into thirteen months or moons. At the beginning of each moon they held a grand festival, which took its name and character from that of the moon. The first moon was called Deer, the second Strawberry, the third Small Corn, the fourth Watermelons, the fifth Fishes, the sixth Mulberries, the seventh Maize, the eighth Turkeys, the ninth Buffalo, the tenth Bears, the eleventh, which corresponds to our January, was called the Cold-meal Moon, the twelfth Chestnuts, and the thirteenth Walnuts, these nuts being ground up and mixed with their food at this season of the year.

The Natchez nation consisted of numerous villages, each of which was governed by its own Sun, or chief, all of whom admitted their inferiority to one great chief, who was considered the head of the nation, and was called the Great Sun. Herriot (History of Canada) graphically describes the dwelling and etiquette of the *levées* of the Great Sun: "The cabin of the Great Sun contained several beds on the left of the entrance; on the right hand was the bed of the Great Sun, adorned with different painted figures. This bed consisted only of a paillasse made from canes and reeds, with a square piece of wood for a pillow. In the center of the cabin was a small boundary, around which any one who entered the apartment was obliged to perform the circuit before he was permitted to approach the bed. Those who entered saluted with a kind of howl, and advanced to the extremity of the cabin, without casting their eyes toward the side where the Great

Sun was seated. They afterward gave a second salute by lifting their arms above their heads and howling three times. If they were persons whom the Great Sun respected, he answered by a faint sigh and made them a sign to be seated; he was thanked for his courtesy by a new howl, and at every question the Sun made they howled once before returning an answer. When they took their leave they drew out one continued howl until they retired from his presence."

From the history of De Soto's invasion it is evident that not only the Great Sun, but all the caciques of Florida, were attended with some rude state. The chief of Cosa, when he visited De Soto, was carried in a litter, wearing on his head a diadem made of feathers, while around him attendants "sang and played upon instruments."

The government of the Natchez is what especially distinguished them from the other tribes of North America. Du Pratz says: "The authority which their princes exercise over them is absolutely despotic, and can be compared to nothing but that of the first Ottoman emperors. Like them, the Great Sun is absolute master of the lives and estates of his subjects, which he disposes of at pleasure," etc. As soon as the presumptive heir of the Great Sun was born, every family in which there was a child at the breast gave that child for his service. When the chief died, all these individuals were put to death, to serve their master in the world of spirits.

The Natchez were divided into nobles and common people, which last, with an arrogance not peculiar to savages alone, were designated "stinkards."

The nobles themselves were divided into Suns, nobles, and men of rank. The Suns, according to tradition, were descended from a man and woman who came down from the sun to teach them how to live and govern themselves. They enjoyed immunity from punishment by death, and their nobility was transmitted only through the female line. Although the children, both male and female, bore the name of Suns, the males enjoyed this honor in their own persons alone. Their male children were only nobles; the next generation were men of rank, and the third lowered them to plain stinkards, although distinguished actions might retard the deterioration of the blood. But the case was very different with the female posterity. They enjoyed through all generations the privileges of their rank. Laudonière speaks of a queen "who was much reverenced by her subjects when he visited Florida."

The nobility never intermarried. As we have already noticed, one of their laws prohibited their being put to death for any reason whatsoever. Another law decreed that when a Sun died, his or her conjugal partner should be put to death at the time of burial. To fulfill these two laws they only married stinkards.

McCulloh states that the Natchez believed mankind to be immortal, and that after death their souls went to reside in another world where they would be rewarded or punished according to their present life. They believed that such as had been faithful observers of the laws were to be conducted to a region of happiness, where their days would pass in pleasure, in the midst of feasts, of dances, and of women; but they believed that the transgressors would be cast on lands unfertile and marshy which would produce no grain. There they would be exposed naked to mosquitoes, and they never should eat but of the flesh of alligators and the worst kinds of fish.

The sun was the principal object of their veneration, and to its honor a perpetual fire was maintained in their temples. The Great Sun, supposed to be the brother of the sun, honored the appearance of his elder brother every morning by a repeated howling, and, having had his pipe lighted, he offered him the first three mouthfuls of smoke, after which he raised his hands above his head and turned from east to west, the course the sun would follow during the day. The temples of the Natchez, like the abodes of the Suns, were built upon mounds erected for the purpose. They were usually about thirty feet square and built of the heart of the cypress tree, which was supposed to be incorruptible.

Du Pratz, who lived among them eight years, relates from their traditions the following history of the institution of the perpetual fire so religiously preserved: The original Sun told them that, "in order to preserve the excellent precepts he had given them, it was necessary to build a temple into which it would be lawful for none but those of royal blood to enter to speak to the Spirit; that in the temple they should eternally preserve a fire which he would bring down from the sun, from whence he himself had descended; that the wood with which the fire was supplied should be pure wood and without bark; that eight wise men of the nation should be chosen to guard the fire night and day; and that if any of them neglected their duties they should be put to death," etc.

Though oral traditions are considered to be of little authority, and are materially perplexed in being handed down from one generation to another, we can still admit that these accounts were originally true. The historical tradition of the Natchez was this: "Before we came into this land, we lived yonder, under the sun" (here the relator pointed nearly southwest, toward Mexico). "We lived in a fine country, where the earth is always pleasant; there our Suns had their abode, and our nation maintained itself for a long time against the ancients of the country, who conquered some of our villages in the plains, but never could force us from the mountains. Our nation extended itself along the great water, where the large river loses itself; but, as our enemies were become very numerous and very wicked, our Suns sent some of their subjects, who lived near this river, to examine whether we could retire into the country through which it flowed. The country on the east side of the river being found extremely pleasant, the Great Sun, upon the return of those who had examined it, ordered all his subjects who lived in the plains, and who still defended themselves against the ancients of the country, to remove into this land; here to build a temple, and to there preserve the eternal fire. A great part of our nation accordingly settled here, where they lived in peace and abundance for several generations. The Great Sun and those who remained with him were tempted to continue where they were, by the pleasantness of the country, which was very warm, and by the weakness of their enemies, who had fallen into civil dissensions, etc. It was not till after many generations that the Great Sun came and joined us in this country, and reported that warriors of fire, who made the earth to tremble, had arrived in our old country. and, having entered into an alliance with our brethren, conquered our ancient enemies; but attempting afterward to make slaves of our Suns, they, rather than submit to them, left our brethren, who refused to follow them, and came hither attended only by their own slaves."

Their tradition also says that after their removal to Louisiana their nation in the height of their prosperity extended from the river Manchac, or Iberville, to the Ohio, or about four hundred leagues; and that they had about five hundred Suns or princes to rule over them.

At the time we become acquainted with the Natchez their nation was nearly destroyed, though from what causes we do not exactly know. They were expelled from the country originally known as Florida about A. D. 1730, a part being driven across the Mississippi, and the remainder incorporating themselves with the Chickasaws and other neighboring tribes; the new confederacy of the Creeks arising upon their ruins. It is probable that their final downfall was caused by De Soto's ferocious and bloody invasion, during which for three years their country was ravaged with fire and sword, and the inevitable consequence of which was an inability to defend themselves against the hostile tribes around them, who probably broke into their country from all directions, and smothered the partial civilization which once distinguished this part of the United States.

SURVIVALS FROM MARRIAGE BY CAPTURE.

BY LIEUTENANT-COLONEL A. B. ELLIS.

AMONG those races of man which have made the least progress in civilization we find that the men of a group or community are in the habit of procuring wives by seizing and carrying off the women of other groups or communities. It is the practice, for instance, among the Fuegians, the Australians, the tribes of the Amazon, some of the aborigines of the Deccan, several of the Malay peoples of the Indian Archipelago, many African tribes, and other peoples too numerous to be here given in detail. Shortly summarized, it may be said that the practice is caused by the scarcity of women, which results from female infanticide, which in its turn is due to the struggle for existence, necessarily hard among savage races who trust wholly to the chase and the spontaneous fruits of the earth for their supply of food. Wherever man lives under such precarious conditions each extra mouth to fill becomes a matter for serious consideration, and as male infants, future hunters and braves, are of more value to the group than female, the latter are slain in a larger proportion. As man emerges from these conditions and cultivates the soil or domesticates animals, the struggle for existence becomes less hard, infanticide diminishes, and the sexes become more equally balanced. But the former condition lasts long. It is probably within the mark to say that several centuries passed away before man commenced to till the soil, and many more before he began to domesticate animals; and during the whole of this time, to judge the past by the present, he probably obtained wives by capture from his neighbors.

Now, after man had for a great number of generations been in the habit of associating marriage with a violent abduction of women, he would inevitably come to regard the two as necessary complements of each other. Man is a creature of habit, and continually perseveres in old customs when their necessity has long passed away, and when even their meaning and intention have been forgotten. Hence, as he has been in the habit of seizing women for wives, he would, even when the necessity for violence no longer existed, still continue to preserve at least the form of it; regarding the acquisition of a wife without some semblance of force as improper, because unusual, and at variance with old custom. As time passed on, this form, or rite, of capture would necessarily become disintegrated, passing from an actual capture to a symbolic capture, and finally dwindling away into a variety of minor ceremonies. These, which we may call forms of survival from marriage by capture, it is the purpose of this paper to classify. They are numerous, examples being forthcoming from every part of the world, and from peoples in every phase of civilization. This, however, is as might be expected, for it is certain that almost every race of man must have passed through the initial stages which gave rise to the practice. The marriage by capture *de facto*, it must be observed, is a violent abduction, regarded as an act of hostility. With this class it is not proposed to deal. The hostile abduction is the actuality; and what we are now about to inquire into are the ceremonial abductions, and practices derived therefrom, the symbols of the former reality.

The different forms of survival so blend one into another, and two are so frequently found combined together, that it is impossible to make a classification that will meet every case; but what it is here proposed to do is to group the forms under general heads, from which the more disintegrated varieties may be traced. For this purpose it will be convenient to divide them into two groups, viz.: (1) Forms which precede the consummation of the marriage; (2) forms which follow it. These two groups may again be divided, the first into (*a*) forms symbolizing a conflict between opposing parties or clans; (*b*) forms symbolizing a capture of a woman, either by a party or by an individual; and (*c*) bride-racing; and the second into (*d*) forms symbolizing an escape or attempt to escape from the husband; and (*e*) forms limiting social intercourse between the young couple and their relatives by marriage.

The form which approaches nearest to the reality, and which is therefore probably the most archaic, is that in which the bridegroom, assisted by his friends, attempts to seize and carry off the bride, the seizure being resisted by her friends. There is a good deal of violence, and the bridegroom is not always successful. We find a good example of this form in Captain Johnstone's Maoria.* Among the New Zealanders an indispensable preliminary to every description of *tawa*, or expedition—whether a *tawa muru*, a *tawa* to confiscate, a *tawa tango*, a *tawa* for carrying off a woman, or a *tawa toto*, a *tawa* to kill or destroy—was to send and give notice, otherwise it would have been stigmatized as a *koharu*, a murder, or act of treachery. The notice once given, the march of the raiding party might follow immediately, or be delayed for an indefinite time, which was sometimes done with the view of throwing the enemy off his guard. In the *tawa tango* described by Captain Johnstone, a young man of the Ngatiroa tribe had fallen in love with a girl of the Mania tribe, and, as there was no reason to hope that a demand for the hand of the

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* Pp. 126 *et seq.*

lady would prove successful, the chief of the Ngatiroa was induced, through the influence of a new wife, the sister of the suitor, to proclaim a *tawa tango*. An ambassadress was sent to give notice to the Mania tribe, and two large canoes full of men accompanied her. The ambassadress saw the *tawa* received at a friendly village, where it was arranged it should remain for a day or two, and then went on to the settlement of the Mania. There she was received with great respect and distinction, nor was there the slightest change made in the manner of her hosts when she announced that a *tawa* would arrive the next day or the day after to carry off a certain maiden. "Of whom did the *tawa* consist?" she was asked; and when the Mania learned that it was only composed of about one hundred and sixty men in two canoes, they felt rather offended at so small a *tawa* coming to attempt the abduction of one of their maidens. However, in the mean time, and without the knowledge of the ambassadress, who would have been obliged by custom to declare the true strength of the party, the *tawa* had been re-enforced by seven more canoes full of men, which had started a few hours after the first two. The warriors in these canoes reached the Mania settlement and hid in a gully close below the *pa*, or stockaded fort, leaving the two original canoes to approach alone. When the Mania saw only these two canoes, they opened the gates of their *pa*, and the chiefs, having marshaled their men, performed the customary dance of welcome. The Ngatiroa who had landed below the *pa*, formed in a long, oblong phalanx, the rear of which rested upon the gully in which their friends lay concealed, and, upon the conclusion of the dance of the Mania, commenced their share in the performance. The oblong wedge, the Maori order of battle, advanced singing in a low tone, and gesticulating in what they would have called a mild manner. On they advanced, the movement raising no suspicion in the breasts of their adversaries, it being part of the customary ritual of the war-dance, until the thin end of the phalanx overlapped the Mania, and stood between them and the gates of the *pa*. Suddenly a change was visible in the antics of the Ngatiroa; their gesticulations became violent, their eyes protruded, their heads were thrown back, and their throats uttered a mighty shout. As the cry passed their lips, a stream of warriors rushed up the banks of the gully and joined the cluster of their comrades, now swollen to a compact mass of six hundred men. When the Mania realized the ruse practiced upon them, they never for a moment thought of giving up the fair cause of the incursion without a struggle. Into the *pa* poured both parties—the Mania to rally round the girl; the Ngatiroa, except the small party expressly told off to carry away the lady, seeking every man an opponent to wrestle with. Each party was anxious to avoid bloodshed, both being "Tribes of the River." The uproar was therefore greater than had they been engaged in actual warfare, it being more difficult to master a man by strength of muscle than to knock a hole through him. At length superior numbers prevailed. Those who fought around the lady were dragged away; she was roughly seized, and such a tugging and hauling ensued that, had she not been to the manner born, she must have been rent in pieces. At last but one young man, a secret admirer of the lady, retained his hold. An active young fellow, he had so twisted his hands and arms into the girl's hair, and fought so vigorously with his legs, that he could not be removed until he was knocked down senseless. The contest ended, and the bride being borne in triumph to the canoes, both parties proceeded to pick up their weapons and smooth their feathers. Everything had been conducted in the most honorable and satisfactory manner. The Ngatiroa had duly declared their intention, and, if they had surprised the Mania, the latter had learned a lesson, and had only succumbed to superior numbers. No lives had been lost; only a few bones broken, which would soon mend, and it would be their turn next time. In the mean time their own characters required them to fulfill the duties of hospitality, and the *tawa* was requested to remain until food was cooked and placed before it,

The Wa Kamba (Africa) observe a form of capture very similar to the foregoing. Among them the bridegroom is required to carry off his bride by force after the preliminaries are completed. This is attempted by the help of all the friends and relatives that the man can muster, and resisted by the friends and relatives of the woman, and the conflict now and then terminates in the discomfiture of the unlucky husband, who is reduced to the necessity of waylaying his wife when she may be alone in the fields or fetching water from the well.

In these examples resistance is offered by both the men and women of the bride's party, even to the extent of causing a failure of the marriage, at all events for a time. The first disintegration, therefore, appears to be when such resistance is still offered, but where, if it be successful, the bride is finally produced and given up to the party of the bridegroom.

This form is observed by the Kookies of the northeastern frontier of India, of whom Colonel McCulloch says: "When they go to bring away the bride, after having paid for her, they usually receive more kicks than halfpence from the village—that is, they usually get well beaten. But, after the fight is over, the woman is quietly brought from her home and given to the party that came for her, outside the village gate." The custom of the Karens (Burmah), mentioned by Sir John Bowring, is a survival, in a disintegrated condition, of this or of the foregoing form. He says, "A candidate for the hand of a virgin must escalade her cabin, and is expected to overthrow a strong man placed in her defense."* A still more disintegrated form is found in Turkey, where the bridegroom is chased by the guests, who slap him on the back and pelt him with their slippers. A curious variation of this ceremony survives among the Arab tribes of Upper Egypt, where, at the marriage feast, "the unfortunate bridegroom undergoes the ordeal of whipping by the relations of his bride." Sometimes the punishment is exceedingly severe, it being administered with a whip of hippopotamus-hide; but, if the bridegroom wishes to be considered a man of gallantry, he must receive the chastisement with an expression of enjoyment. After the flogging, the bride is led to the bridegroom's residence.†

The next disintegration appears in those cases in which resistance is offered only by the women of the bride's party, the men remaining passive. This form prevails among the Khonds in the hill tracts of Orissa (India). The bridegroom, assisted by a party of twenty or thirty young men, carries off the bride, in spite of the desperate attacks of her female friends, who hurl stones and bamboos at the head of the devoted bridegroom, until he reaches the confines of his own village. The same form is observed by the Kolams of the Pindi Hills (India), by the Mosquito Indians (Central America), and by the Eskimos of Cape York. A variation is found in the kingdom of Futa, Senegal, West Africa, where the bridegroom and party come to the house of the bride by night and endeavor to carry her off. In this they are resisted by all the girls of the village. A very disintegrated form of this variety seems to have been in vogue at royal marriages in Ceylon. Dr. Davy tells us that the king and queen threw perfumed balls and squirted scented water at each other. In this the *wives* of the chiefs took part, and were at liberty to pelt and bespatter even royalty itself as much as they pleased.‡

We pass now from cases in which actual violence is offered to those in which violence is merely simulated. The first of these is that in which there is a sham fight between the opposing parties. This form is very widely distributed. Colonel Dalton mentions that, among the Kols of central India, when the price of a girl has been arranged, the bridegroom and a large party of his friends of both sexes enter with much singing and dancing and sham fighting into the village of the bride, where they meet the bride's party, and are hospitably entertained.# The Malays of the Strait

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* Kingdom and People of Siam, vol. ii, p. 45.

† Sir S. Baker, Nile Tributaries of Abyssinia, p. 125.

‡ Account of Ceylon, p. 166.

\# Ethnology of Bengal.

of Macassar have first a sham fight outside the town, then a feigned resistance at the gates, and afterward, from point to point, a show of disputing the advance of the bridegroom and his party, until they have made their way to the bride's house.* In Abyssinia, the party of the bridegroom go through a sham fight outside the bride's house, then enter it, and the bridegroom, taking the bride, hurries her out and hands her over to some of his friends. Returning to the house again, he then takes part in the *deball*, or war-dance, which is a simulated combat with guns, spears, and swords, and in which the parties of the bridegroom and bride are ranged on opposite sides.† "In New Zealand," says the Rev. R. Taylor,‡ "even in the case when all were agreeable, it was still customary for the bridegroom to go with a party, and appear to take her away by force, her friends yielding her up after a feigned struggle." In Berry, France, the house of the bride is barricaded, and a sham assault of it takes place. After some parley the bridegroom's party is admitted, and a struggle for the possession of the hearth is then simulated. In Little Russia, in peasant weddings, when the bride's tresses have been unplaited and the cap is being put on her head, she is bound to resist with all her might, and even to fling her cap angrily on the ground. Then the groomsmen, at the cry of "Boyars to your swords!" pretend to seize their knives and make a dash at the bride, who is thereupon surrounded by her friends, who come rushing as if to her rescue.#

It is interesting to note that this form survived among the Celtic inhabitants of the British Isles until very recent times. Lord Kames describes it as it existed in his day among the Welsh, as follows: "On the morning of the wedding-day the bridegroom, accompanied by his friends on horseback, demands the bride. Her friends, who are likewise on horseback, give a positive refusal, on which a mock scuffle ensues. The bride, mounted behind her nearest kinsman, is carried off, and is pursued by the bridegroom and his friends with loud shouts. It is not uncommon on such an occasion to see two or three hundred sturdy Cambro-Britons riding at full speed, crossing and jostling, to the no small amusement of the spectators. When they have fatigued themselves and their horses, the bridegroom is suffered to overtake the bride. He leads her away in triumph, and the scene is concluded with feasting and festivity." ‖ Sir Henry Piers's description of it, as observed by the Irish, is: "On the day of bringing home, the bridegroom and his friends ride out and meet

* Moore's Marriage Customs, p. 196.

† Life in Abyssinia, p. 51.

‡ Te Ska Amani, p. 163.

Ralston's Songs of the Russian People, pp. 284, 285.

‖ History of Man, p. 449.

the bride and her friends at the place of meeting. Being come near each other, the custom was of old to cast short darts at the company that attended the bride, but at such a distance that seldom any hurt ensued. Yet it is not out of the memory of man that the Lord of Hoath on such an occasion lost an eye. The custom of casting darts is now obsolete." * Among the Highlanders of Scotland it was the custom for the parties of the bride and bridegroom to go in procession to a point of meeting midway between their dwellings, and, when they came near each other, to fire volleys at one another from pistols and muskets.

The next disintegration seems to be found in those cases in which all show of resistance to the party of the bridegroom is limited to closing the house against it. Several varieties of this form occur among the southern Slavs. In Croatia, the bride and her friends being assembled, all the doors of the house are closed to prevent a surprise by the bridegroom's party. The assembled guests are on the alert, and, as soon as they hear the party approaching, all the lights are put out and all keep silence. The visitors knock repeatedly without getting any answer, but at length they advance various pretexts to get admission, and at last, after a long parley, are admitted. In Dalmatia and Bulgaria the door is similarly closed against the bridegroom's party, and admission only obtained on payment. In Transylvania the doors are closed, and the bridegroom must, as best he can, climb over into the court, open the door from within, and admit his companions.

We now come to those forms in which no resistance, either real or feigned, is offered by the party of the bride, who merely simulate grief or terror, and it is the party of the bridegroom alone which makes a show of violence. This was the form observed by the Romans in plebeian marriages, and a full description of it is given in the Golden Ass of Apuleius, in the story of the Captive Damsel, where the bride, describing how she was carried off, says that a band of men, armed with swords, rushed in, and, without meeting with any resistance from the inmates, tore her from her mother. The Circassians have the same ceremony, it being the custom to give a feast, in the midst of which the bridegroom rushes in and, with the help of some companions, carries off the bride by force. This form, in a very disintegrated condition, is found in the isle of Skye and the west Highlands of Scotland, in the ceremony known as "stealing the bride." It occurs in the middle of a reel. The groomsman and bridesmaid slip into the place in the dance of the bridegroom and bride, while the bridegroom suddenly jerks the bride out of the room.

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* Description of Westmeath.

The foregoing are the general types of the forms of survival in which the party of the bride is represented. We have traced the various stages of disintegration from actual resistance offered by both the men and women of the bride's party, to the offering of such resistance terminated by a surrender of the bride, and then to resistance being offered by the women only. Thence, from feigned resistance evinced by a sham fight, it passed to the mere closing of the house, and finally to the form in which no resistance is simulated. The semblance of hostility to the party of the bride gradually dwindles away till it is reduced to merely tapping the father and mother of the bride on the shoulder with a small stick, as is done by the Samoyeds, or to the pretense of tearing the bride from the arms of her mother, as is the custom in Sardinia. To come down to ourselves, it is very probable that the practice of throwing an old shoe after the departing bride and bridegroom is a last surviving relic of the form of a struggle between opposing parties.

It is difficult to say to what class such ceremonies as that observed by the Mundaris of Bengal, where an arrow is fired through the loophole formed by the arm of the bride as she holds a pitcher of water on her head, and by the Romans, where the bride's hair was parted with a spear, belong; but the use of weapons seems to justify us in regarding them as very disintegrated survivals of our subhead (*a*). Perhaps the custom observed in Anglo-Saxon marriages, where the father delivered the bride's shoe to the bridegroom, and the latter tapped her on the head with it, is also one.

We come now to our subhead (*b*). The forms of capture of this class seem to be symbolic of a capture of a woman by surprise or stratagem. In these, though the bride is carried off with real or pretended violence, her friends offer no opposition and feign no grief. It is no longer a struggle between clans, and there is no longer a party supporting the bride.

First of this class is that form in which the girl is carried off *nolens volens*. The consent of the parents to the marriage has been obtained, and all the preliminaries settled, but in most cases the girl has received no warning of what is about to take place. Sometimes, of course, she may have received a hint, but in this form she is not necessarily a consenting party, and her resistance is violent. Among some peoples it is usual for the bridegroom to be assisted by one or two friends; among others he carries out the abduction alone. The first represents capture by a war party, the second by an individual, but the latter form is comparatively rare.

Of cases in which the bridegroom is assisted by his companions we find examples—1. Among the Mandingo tribes settled along the banks of the river Gambia, in West Africa, where, after the "head" or purchase money has been paid to the parents, the bridegroom, aided by two or three friends, seizes the girl while she is engaged in her ordinary domestic vocations, and, in spite of her frantic struggles, carries her off. 2. Among the Bedouin Arabs of the Sinai Peninsula, where, after all the arrangements have been made with the parents, the bridegroom, assisted by two friends, seizes and carries off the bride. "If she entertains any suspicion of their designs," says Burckhardt, "she defends herself with stones, and often inflicts wounds on the young men, even though she does not dislike the lover; for, according to custom, the more she struggles, bites, kicks, cries, and strikes, the more she is applauded ever after by her own companions."* 3. Among the Indians of the Amazon Valley, of whom Wallace says: "When a young man wishes to have the daughter of another Indian, his father sends a message to say he will come, with his son and relations, to visit him. The girl's father guesses what it is for, and, if he is agreeable, makes preparations for a grand festival. This lasts, perhaps, two or three days, when the bridegroom's party suddenly seize the bride and hurry her off to their canoes. No attempt is made to prevent them, and she is then considered as married."† Of cases in which the bridegroom is unaided we have an example among the Fijians, with whom it is clear that the consent of the girl is not first obtained, for, says Mr. Williams, "on reaching the home of her abductor, should she not approve of the match, she runs to some one who can protect her; if, however, she is satisfied, the matter is settled forthwith."‡

The first disintegration of this form is seemingly when the bride is a consenting party, knows well enough what is about to take place, and merely offers a feigned resistance. This appears to be the form observed by the southern tribes of Tierra del Fuego, where, according to Captain Fitzroy,# the youth, having obtained the consent of the girl's relations, and having provided himself with a canoe, watches an opportunity and carries off the bride. If she is unwilling, she hides herself in the woods until her admirer is heartily tired of looking for her and gives up the pursuit. The Spartans also observed this form. In most cases the bride is carried to the house of the bridegroom, but among the Indians in the neighborhood of Concepcion, the bridegroom carries off the bride to the woods, the happy pair returning home after a day or two. Among the Tangutans (Mongolia) *wives* may be abducted. Lieutenant-Colonel Prejevalsky says: "They

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* Notes, vol. i, p. 263. † Travels on the Amazon, p. 497. ‡ Fiji and the Fijians, p. 174.

Voyages of the Adventure and Beagle, vol. ii, p. 182.

have a curious custom of stealing their neighbors' wives, of course not without their secret assent. In such cases the stolen wife belongs to her ravisher, who pays the husband a good sum as compensation." *

The next disintegration is, perhaps, to be found in those cases in which the women seize the bride and drag her to her suitor's house. This form occurs among the Greenlanders.

The next is where the violence, or feigned violence, takes the form of tearing the bride's clothes. This form is found among the Tunguses and Kamchadales, of whom Ernan says a matrimonial engagement is not considered as definitely concluded till the lover has got the better of his bride "and has torn her clothes." † A variety of this form is found in Circassia, where an important part of the marriage ceremony consists in the bridegroom drawing his dagger and cutting open the bride's corset.

The next is where the appearance of violence is still further eliminated, and custom only requires the bridegroom to carry his bride to his house. This form is observed by the Indians of Canada, where the bridegroom takes his wife on his back, and, amid the plaudits of the spectators, carries her to his tent.‡ The Western tribes of North America "regard it as an important part of the marriage ceremony that the bride should be carried to her husband's dwelling. In Mexico, also, the husband took the bride on his back and carried her a short distance. Bruce, in Abyssinia, observed an identical custom." # Speke witnessed a similar ceremony at Karague, East Africa, and this form is also observed by the Susus, West Africa, with whom, however, the bride is sometimes carried on the back of a woman.

From carrying the bride on the back, to simply lifting or forcing her over the threshold of the bridegroom's house, the transition is easy. In the patrician marriages of the Romans the bridegroom had to carry the bride over the threshold of the house, and among the Bedouin Arabs it is necessary for the bridegroom to force the bride to enter his tent. A similar custom existed among the French, at least in some provinces, in the seventeenth century. At Sparta, after the actual carrying off of the bride had fallen into desuetude, the bridegroom had to take up the bride and carry her from one room to another. In China, before the bridal procession starts, the young sisters and female friends of the bride come and weep with her till it is time to leave the house of her parents; and when the procession reaches the bridegroom's house the bride is carried into the house by a matron, and lifted over a pan of charcoal at the door. A variation of this

* Mongolia, vol. ii, p. 121.

† Siberia, vol. ii, p. 442.

‡ Carver's Travels, p. 274.

Origin of Civilization, p. 88.

form is found in North Friesland, where a young man, called the bride-lifter, lifts the bride upon the wagon in which the married couple are to travel to their house. The last stage is reached in the form seen by Denham at Sockna, North Africa. The bride is taken on a camel to the bridegroom's house, and, upon arriving there, "it is necessary for her to appear greatly surprised, and refuse to dismount; the women scream, the men shout, and she is at length persuaded to enter." *

Finally, an affectation of grief on the part of the bride is the sole demonstration of a feigned compulsion. Such a case was witnessed by Mrs. Atkinson, in Siberia.† It is there the custom for the bride to be taken to the bath on the eve of her wedding-day by her young companions, and in this case the road to the bath led past the house where Mrs. Atkinson was stopping. Startled by most heart-rending sobs, that lady hastened to the gate and found a bride being supported by her young friends to the bath. She thought it was a case in which a girl had been forced to accept an unwelcome suitor, and was filled with compassion. When the girl returned from the bath she was still sobbing and quite bowed down with grief. An hour or two later, Mrs. Atkinson went to the bride's cottage and found the damsel eating supper, her face radiant with joy. She asked if she had *done it well,* and Mrs. Atkinson then learned, to her great surprise, that the weeping was part of the ceremony.

We now come to that form of survival which has been termed "bride-racing," and which we have placed under subhead (*c*). The least disintegrated variety of this form of capture is that in which there is a *bona fide* chase, out of doors, and which does not always end in favor of the lover.

We find this form among the Calmucks, with whom, says Dr. Clarke, the ceremony of marriage is performed on horseback. "A girl is first mounted, who rides off in full speed. Her lover pursues; if he overtakes her she becomes his wife, and the marriage is consummated on the spot; after this she returns with him to his tent. But it sometimes happens that the woman does not wish to marry the person by whom she is pursued; in this case she will not suffer him to overtake her. We were assured that no instance occurs of a Calmuck girl being thus caught, unless she have a partiality to the pursuer." ‡ This is slightly varied among the Kirghiz, the young woman, who is pursued by all her suitors, being armed with a formidable whip, which she does not hesitate to use if overtaken by a lover who is disagreeable to her. Among the Turkomans the bride carries in her lap the carcass of a sheep or goat, which the pursuer has to snatch from her. The Malays,

* Travels in Africa, vol. i, p. 39. † Tartar Steppes, pp. 218, 219. ‡ Vol. i, p. 433.

who are eminently an aquatic people, carry out this ceremony on the water. The bride is given a canoe and a double-bladed paddle, and allowed a start of some distance; the suitor, similarly equipped, then follows in chase. If he succeeds in overtaking her, she becomes his wife; if not, the match is broken off.* Among the wild tribes of the Malay Peninsula the chase takes place in the forest, on foot.

The first modification of this form is when the chase takes place in a set race-course, instead of in the open country. This is done by the Malays when there is no stream suitable for the boat-chase near at hand. A circle of a certain size is formed, the damsel, stripped of all but a waistband, is given a start of half the circle, and, if she succeeds in running three times round before her suitor catches her, the marriage is off. Among the Koriaks (northeastern Asia) the race takes place in a large tent, containing numerous separate compartments, called *pologs*, arranged in a continuous circle around its inner circumference; and the girl is clear of the marriage if she can run through the series of *pologs* without being caught. In this case the women of the encampment throw every obstacle in the way of the bridegroom—try to trip him up, and strike him with switches; so that here we have a combination of bride-racing with that form of capture in which resistance is offered by the women of the bride's party. A man has scarcely any chance of succeeding unless the woman wishes it. In a chase witnessed by Mr. Kennan † the bride distanced the lover, but waited for him in the last *polog*.

From this variety the form passes through various stages of disintegration. Among the Aenezes (Arabs) the girl runs from the tent of one friend to another. Here, however, she is caught by the women, and conducted to the tent of the bridegroom, who stands at the entrance and forces her in. Among the Oleepa Indians of California the girl runs away and hides herself. "The lover searches for her, and, should he succeed in finding her twice out of three times, she belongs to him. Should he be unsuccessful, he waits a few weeks and then repeats the performance. If she again elude his search, the matter is decided against him." ‡ Among the Ahitas, or Aetas, the Negrito race of the Philippine Islands, the girl is sent away into the forest, by her parents, before sunrise. She has an hour's start, after which the lover goes in search of her. If he finds her before sunset, the marriage is acknowledged; if not, the affair is at an end. Among the Wateita (eastern Africa) the bride hides with distant relatives. Finally, the form becomes merely an elopement of the happy

* Cameron's Malayan India, p. 116.

† Tent Life in Siberia.

‡ Bancroft's Native Races of the Pacific States, p. 389.

pair, as among the Soligas (India), where the girl and her lover run away to some neighboring village.

The survivals which follow are in such a disintegrated condition that it is impossible to decide to which class they may properly be referred. It will have been observed that, in all the ceremonies that have been described, the bridegroom is pretended to be regarded as an enemy, a person to be avoided. Hence we can understand the Abyssinian custom described by Mr. Mansfield Parkyns,* who says that, as soon as a young man has become betrothed to a girl, he may not see her face. If he should chance to see her by stealth, she covers her face, screams, runs away, and hides; and this though the greatest intimacy may have prevailed between them before the betrothal. A modification of this custom is found in Ceylon, where, if a young man wishes to see the bride whom his father has selected for him, he must go clandestinely. If he enters the house it must be under a feigned name, and if he sees his intended he must not address her.†

If the bridegroom is to be regarded as hostile to the bride, he must, by a similar fiction, be regarded as hostile to her family also; and hence the many cases in which proposals for marriage must be made through the intervention of third parties, a custom which has neither utility nor convenience to recommend it. Among the Turkomans "the young man does not dare to breathe his wishes to the parents of his beloved, for such is not etiquette, and would be resented as an insult." ‡ In Siam marriages are the subject of much negotiation, undertaken not directly by the parents, but by "go-betweens," nominated by those of the proposed bridegroom, who make proposals to the parents of the intended bride.# Davis says the same of the Chinese,‖ and that the two persons principally interested never see each other. In Dahomey it is the custom for a suitor to dispatch two emissaries, a man and a woman, to open negotiations with the family of the girl he wishes to marry. In Samoa, Mr. Pritchard says,^ a man never personally woos his lady-love, and, in the case of a chief, it is the privilege of his attendants to do the courting for him.

These customs are evidently disintegrations of that observed by Caillié in the western Soudan. There, as soon as the suitor has declared himself, he is not allowed to see the father and mother of his future bride. He takes the greatest care to avoid them, and if by chance they perceive him they cover their faces, as if all ties of friendship were broken. The custom extends beyond the relations; for, if the lover is of a different camp, he

* Life in Abyssinia, vol. ii, p. 41.

† Account of Ceylon, p. 285.

‡ Fraser's Journey, vol. ii, p. 372.

Bowring, vol. i, p. 118.

‖ Chinese, vol. i, p. 266.

^ Polynesian Reminiscences, p. 134.

avoids all the inhabitants of the lady's camp, except a few intimate friends, whom he is permitted to visit. A little tent is generally set up for him, under which he remains all day, and if he is obliged to come out, or to cross the camp, he covers his face.*

We now pass to the second group of survivals, namely, those which follow the consummation of the marriage. Our first subhead of this group symbolizes an escape, or attempted escape, from the husband.

The least disintegrated example appears to be that which occurs in Zululand, where custom requires that the bride should make three attempts to run back to her old home, but the last attempt, made on the second day, and after she has been installed in her position as wife, is the only serious one. Should she succeed in escaping, the whole marriage ceremony has to be gone through again.†

The first modification of this is when the bride simply returns to her parents' house for a certain time. There is no appearance of flight, but there is a complete rupture of cohabitation. This custom is found among the Ewe-speaking tribes of the Slave Coast (West Africa), the wife, after a week's cohabitation with her husband, returning to her old home for a week. In Chittagong, husband and wife are on no account permitted to sleep together until seven days after marriage.

The next modification is where the bride returns to her former home, but sees her husband by stealth. This form is observed by some of the Turkoman tribes, the bride returning to her father's house, "where, strange to say, she is retained for six months or a year, and sometimes two years, according, as it appears, to her caprice or the parents' will, having no communication with her husband, unless by stealth." ‡ According to Plutarch, the Spartans had the same custom, and some husbands even had children by their wives before they could see them otherwise than clandestinely.# Among the Fijians husband and wife do not usually pass the night together, except as it were by stealth; and Lafitau says the same of some of the North American Indians. In Crete it was the custom for married people to see each other clandestinely for some time after the wedding, and a similar custom is said to have existed among the Lycians.

A variation of these forms exists among the Arabs of the Mezeyne tribe (Sinai Peninsula), where the bride runs away to the mountains every evening, being followed by her husband, and returns to her mother's tent every morning. This is done for several days, after which she returns to her mother, and she does not

* Travels to Timbuctoo, vol. i, p. 94.

† Leslie's Among the Zulus, pp. 116–118.

‡ Fraser's Journey, *loc. cit.*

Lycurgus, c. 15.

go to live with her husband till she is far advanced in pregnancy. If she does not become pregnant, she may not live in her husband's tent till a full year from the wedding-day.*

Our second subhead of this group comprises those forms in which social intercourse between the husband and the tribe, relations, or parents of the wife is forbidden. He is pretended to be regarded as an enemy who has robbed them of one of their number.

An example of the most complete form of this custom, occurring before marriage, has already been quoted from Caillié, and, apparently, the restrictions remain in force after marriage, at all events for a time. In most cases, however, the restriction is limited to the relations of the bride. This, according to Rochefort,† was the case with the Caribs. He says: "All the women talk with whom they will, but the husband dares not converse with his wife's relatives, except on extraordinary occasions." Baegert describes a similar custom among the Indians of California, with whom the son-in-law was not allowed to look in the face of his mother-in-law, or his wife's nearest relations, but had to step on one side, or to hide himself when they were present.‡ In Florida, the parents-in-law did not enter the son-in-law's house, nor he theirs, nor his brothers-in-law, and, if they met by chance, they went a bow-shot out of their way, with their heads down and eyes fixed on the ground, for they held it a bad thing to see or speak to one another.#

Among other peoples the restriction is limited to the mother-in-law, and this form is very wide-spread. It is, or was, observed by the Indians of North America generally, and by many tribes in South America. In Africa the custom is found among the tribes of the Gold Coast, the Mpongwe of the Gaboon, and the Bushmen. The Zulu and his mother-in-law may not mention one another's names, nor look in one another's faces. If they chance to meet they pretend not to see each other, the man hiding his face with his shield.‖ In Australia "it is compulsory on the mothers-in-law to avoid the sight of their sons-in-law, by making the mothers-in-law take a very circuitous route on all occasions to avoid being seen, and they hide the face and figure with the rug which the female carries with her." The custom which, among the Banyai of South Africa, compels a man to sit with his knees bent in presence of his mother-in-law, and forbids him to put out his feet toward her, has perhaps something to do with this form, as, no doubt, has also the proverbial hostility

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* Burckhardt, vol. i, p. 269.

† Hist. Nat. des Îles Antilles, p. 545.

‡ Smithsonian Reports, 1863–'64, p. 368.

\# Tylor, Early History of Mankind, p. 289.

‖ Lubbock, p. 14.

between men and their mothers-in-law of which modern humorists make so much.

That a similar series of prohibitions should exist, limiting the social relations of the wife with the family of her husband, is what we might expect to find; the husband's relatives being of the party of the feigned abductor, and so enemies. Among the Calmucks the daughter-in-law must not speak to her father-in-law, nor sit in his presence. In China, the father-in-law, after the wedding-day, never sees the face of his daughter-in-law again; he never visits her, and, if they chance to meet, he hides himself. With the Ostiaks of Siberia and the Basutos of South Africa the young wife must not look in the face of her father-in-law, and must avoid him as much as possible, till she has borne a child. The Armenian wife must conceal her face from her husband's father and mother. A more archaic form of these varieties is found among the Kaffirs of South Africa, with whom a married woman is cut off from all intercourse, not only with her father-in-law, but with all her husband's male relations in the ascending line. "She is not allowed to pronounce their names, even mentally; and whenever the emphatic syllable of either of their names occurs in any other word, she must avoid it, by either substituting an entirely new word, or at least another syllable in its place." *

This terminates our collection of examples, though we might probably add to those which follow the consummation of the marriage the widely distributed custom which forbids husband and wife to eat together. The numerous cases we have given show how very universal marriage by capture *de facto* must have been, and also, since it has left such enduring traces, for what a long period of time it must have been practiced. Among ourselves it influenced public opinion until comparatively recent times, for it was not until the reign of Henry VII that the violent seizure of a woman was made a criminal offense, and even then the operation of the statute was limited to the abduction of women possessed of lands and goods. A man might still carry off a girl, provided she was not an heiress; but in spite of the law and its severe penalties, the abduction of heiresses continued to be a common occurrence, especially in Ireland, down to the close of the last century, and to be regarded by the general public as but a venial offense at most.

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* Maclean, Compendium of Kaffir Laws and Customs.

THE CHARACTERISTICS OF INSECTS.

By LOUIS MONTILLOT.*

INSECTS, arachnids or spiders, myriapods and crustaceans, are all included in the sub-branch of the arthropods or joint-limbs. Of the characteristics by which they are distinguished we mention here only the most salient. Insects have six legs, arachnids eight, and myriapods a more considerable number, but always short of ten thousand. The legs of crustaceans are variable in number; they have a carapace consisting of the external skeleton, which, being impregnated with carbonate and phosphate of lime, is always consistent and sometimes very hard.

The body of insects is divided into three distinct parts: the head, the thorax, and the abdomen. We may therefore define insects as articulated animals with six legs, having head, thorax, and abdomen distinct.

The life of the insect comprises four successive stages: those of the egg, the larva, the pupa, and the perfect insect. The rule, however, is subject to some interesting exceptions. The reproduction of insects usually takes place through sexual connection. The eggs are fertilized while passing through the oviduct of the female; but the females of certain bees, some of the butterflies, and several aphides, lay fertile eggs without the assistance of the male; this phenomenon is known as parthenogenesis. With some other species the females are viviparous.

The egg is composed of a firm shell, containing a limpid liquid that includes the germ of the embryo and the vitelline globules which are destined to nourish it. The eggs of insects are of the most diversified forms. The shells of many are adorned with remarkable figures. At the moment of hatching, the shell breaks, or rather opens like a hinged box-cover. A large number of the eggs look like seeds. Some are round, others cylindrical, conical, or hemispherical. Others represent solid forms, either flattened or terminating in a point. A curious study is furnished by the art with which the females deposit their eggs. Here we find single eggs; there we see them collected in considerable numbers within a parchment or silken protective envelope, which floats on the water, or is inserted in bark or attached to a stone. At other times we find a chaplet of symmetrical beads, arranged in closed rings around the branch of a tree. To deposit her eggs, the female bores with her ovipositor into the stems of plants, the tissues of animals, or the timbers of our houses. There are no old tree-trunks or cracked walls that may not serve her for a hatch-

* Translated from the book L'Amateur d'Insects. Paris: J. B. Baillière et fils, 1890.

ing place. The female takes care to place her eggs in conditions which will permit her progeny to find food for themselves from birth; but her solicitude usually ends at this point, while she leaves it to the rays of the sun to do the rest—a happy arrangement, for in most cases the parents die before the hatching. The embryo is developed rapidly under the influence of the ambient heat, and in a short time breaks the shell or springs the cover.

From the egg issues a being very little or not at all like its parents. Insects, indeed, undergo, before attaining full development, a series of transformations which are designated as metamorphoses. These metamorphoses are complete or incomplete; and there are even what we might call hypermetamorphoses, as in the case of the cantharides, the evolutional life of which, only recently well understood, is much more complicated than that of most other insects. The metamorphosis is said to be incomplete when the forms of the young insects, on coming out from the egg, are like those of the adult. Insects whose metamorphoses are complete come from the egg in the form of larvæ.

The growth of the insect all takes place during the larval state, and is very rapid. The superficial envelope soon becomes too small for the body it contains. So, at determinate periods of their existence, larvæ change their skin, or, to speak more accurately, burst the integument which envelops them, and shed it. This transformation constitutes the molting, which is repeated from three to eight times, according to the species. During these periods of transition, the larva, as if ill, loses its insatiable appetite, ceases to eat, and becomes stationary.

Insects of incomplete metamorphosis likewise acquire their full development through successive moltings. Each of the moltings is attended by a corresponding perfectionment of some part of the organism.

Larvæ of insects often have a horned head, with jaws that permit them to crush food. This conformation also occurs in the larvæ of insects which in the adult state have the mouth organized for suction. Some larvæ of *Dipteræ*, however, have the fore part of the body terminated by a pointed and retractile appendage; they might be spoken of as acephalous.

After the head come the rings, very like one another, and not exceeding a dozen in number. In these there are three varieties of structure: larvæ having only articulated legs (Fig. 2, upper); those having both articulated and membranous legs; and apodous larvæ, or those having no legs (Fig. 2, lower).

In the first variety the articulated legs, which end in one or two claws, are attached to the three rings immediately following the head, each ring supporting a pair of legs. The same rings form, at a later stage, the thoracic casing of the perfect insect.

In the second variety the articulated legs are six in number. They are, besides, inserted as already described, but the fourth

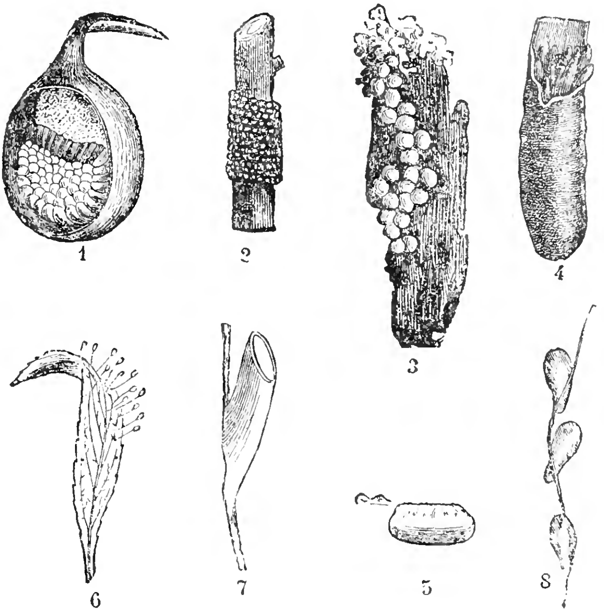


Fig. 1.—Eggs of Insects. 1. Eggs of *Coleoptera* (opened shell of *Hydrophilus piceus*). 2. Eggs of Moths (*Bombyx neustria*). 3. Eggs of Moths (*Lasiocampa pini*). 4. Eggs of *Orthoptera* (*Acridides*). 5. Eggs of *Orthoptera* (*Blatta*). 6. Eggs of *Neuroptera* (*Hemoroba*). 7. Egg of *Diptera* (*Œstrides*). 8. Eggs of Louse.

and following rings are furnished with fleshy protuberances, without articulations, which are designated as membranous legs.

In the third variety, larvæ are regarded as apodous, in which, while they have no articulated legs, the locomotive apparatus is often represented by pads similar to the membranous legs.

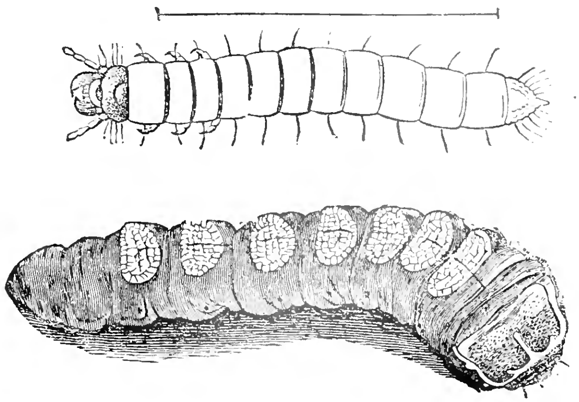


Fig. 2.—Larva with Articulated Legs, and Apodous Larva.

Some larvæ bear silky tufts, others a sort of spines, and others fleshy appendages of curious forms. Many, like certain caterpillars, wear a brilliant livery, while others present a dull color that offers to the eye only false tones, passing from a dirty white to a maroon, with some parts—the head, for example—remaining darker.

Larvæ are to be found, we might say, everywhere and in everything—on the leaves and roots and in the interior of plants, under the ground, in putrefying matter, in the tissues of living animals, in cloths, and in water. Wherever they are found, these larvæ are busy, before everything else, in alleviating the hunger of the moment. They devour, and they gorge themselves, without taking any care to protect their existence against aggressors from without. But a more provident minority construct shelters for themselves—little movable houses which the animal carries with itself, and within which it withdraws in case of danger, like a turtle in its shell. The larva fixes itself to this refuge by means of its membranous legs, and moves without by its articulated legs. The materials necessary for the construction of the nest are gathered up in the element in which the animal lives. They are twigs, grains of sand, fragments of shells, collected in water by the *Phryganeidæ*, shreds taken from our cloths by the *Tineidæ*; earthy substances by the *Chythra*; and all are glued together by the secretions of the insect.

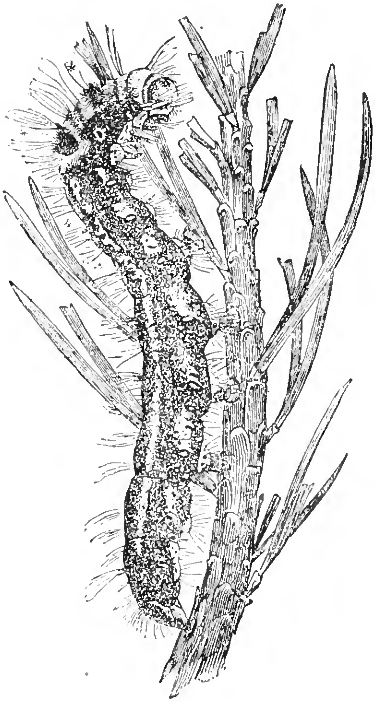


Fig. 3.—Larva with Articulated Legs and with Membranous Legs.

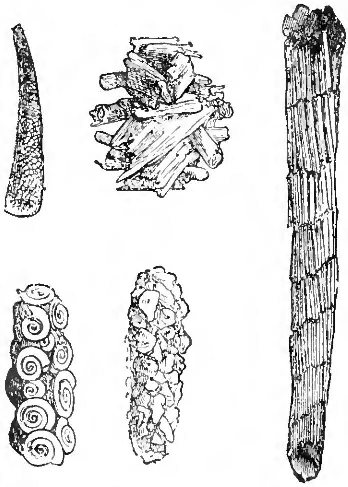


Fig. 4.—Cases of Phryganides.

Whether in the open air or in water, or in the bottoms of underground chambers, larvæ, at a certain period of their evolution, undergo another change, and are transformed into nymphæ. Among the insects of incomplete metamorphosis, the nympha is but little different from the larva, and molts and is fed in the same way. Insects of complete metamorphosis act very differently: the larva becomes stationary and ceases to take food; the skin becomes like parchment, and slight movements of the abdominal rings, when they are touched, are the only signs of life. Yet, from the beginning of the transformation, on the seemingly half-dead being, appear distinctly, although masked by a thick veil, the antennæ, wings, and legs. These organs are symmetrically folded along the body, and the motionless nympha under the veil presents the forms of the perfect insect. It remains sometimes fastened to a wall or hanging from a branch by one of the silky threads which the larva has woven; in other cases it is enveloped in a firm shell or surrounded by a silken cocoon. Nymphæ thus protected remain in the open air, while others, less well guarded, find shelter from bad weather and the direct force of the sun often by being buried deep in the ground.

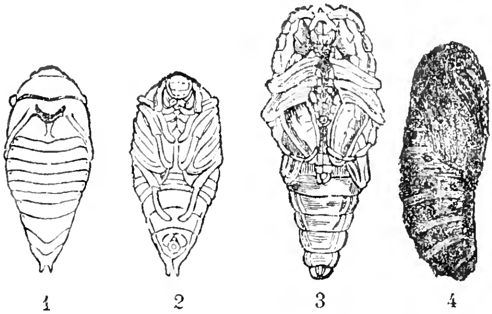


FIG. 5.—1. Nympha of Cockchafer, seen from above. 2. Nympha seen from below. 3. Nympha of Cerambyx. 4. Chrysalis of Bombyx.

The insect secures its release from its nymphal envelope at the expense of violent muscular efforts. Sometimes the envelope splits in the back and gives passage in succession to the thorax, the head, the legs, and the wings; sometimes the hinged lid or operculum which closes the shell gives way under the pushing of the prisoner. At the moment of emerging, the young animal is not able to fly; its wings are crumpled and soft, but the circulation soon becomes more active, the wrinkles vanish, and the wings acquire sufficient consistency to permit the new being to take flight.

As we have already seen, the body of the adult insect may be divided into three principal and distinct parts—the head, the thorax, and the abdomen. The head (Fig. 6) bears the mouth, antennæ, and eyes; the three pieces that follow are the three united rings that constitute the thorax. After the thorax comes the abdomen, the rings of which are movable and capable of gliding upon one another.

The head may be divided into several regions, which it is important to define well. They are, in fact, of great assistance in the description and determination of species. They are four in number: the front, including the space between the eyes; the vertex, or upper part of the head, behind the eyes; the cheeks, below and in front of the eyes; and the *epistoma*, sometimes called the hood, prolonging the front, and running down in front of the mouth. The head is generally articulated with the prothorax by a fine ligament, which leaves it more or less freedom of motion in all directions.

The mouth of insects is arranged to masticate, lick, or suck food. The buccal parts are of course fitted to their purpose, but the type to which all should be referred is the masticatory apparatus, which, by repeated applications to functions foreign to its

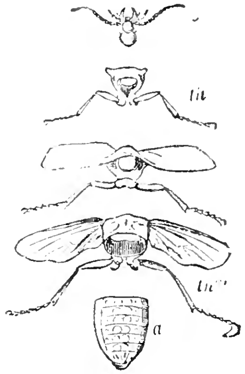


Fig. 6.—Parts of which the Body of a Coleopter is composed. *c*, head; *th'*, first ring of the thorax (prothorax); *th''*, second ring of the thorax (mesothorax); *th'''*, third ring of the thorax (metathorax); *a*, abdomen.

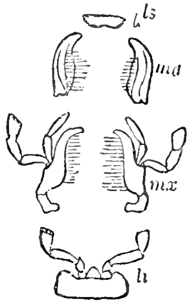


Fig. 7.—Mouth of a Masticating Insect. *ls*, labrum; *md*, mandibles; *mx*, jaws and maxillary palpi; *h*, lower lip and labial palpi.

primary destination, has been insensibly modified and at last transformed, according to circumstances, into a licking or sucking apparatus. The buccal organs of masticating insects move laterally, after the manner of scissors, while the jaws of vertebrates work up and down, like pincers.

When we examine the mouth of the masticating insect, we find in it parts in the order indicated in Fig. 7. First is an upper lip, or *labrum*, *ls*; second, a pair of upper jaws, or mandibles, *md*; third, a pair of lower jaws furnished with maxillary palpi, *mx*; and fourth, a pair of labial palpi supported by a lower lip, *h*, which is itself attached to the border of the buccal cavity forming the chin. The articulated mandibles on the cheeks are strong pincers, which sometimes attain a very considerable development. They are often dentated on their inner border.

The lower jaws are composed of several pieces. Their inner lobe is frequently furnished with a brush of silky threads, and sometimes ends in a little mobile tooth, such as may be remarked among the *Cicindelæ* (*Coleoptera*). The outer lobe is often articulated in the same way as the palpi. The insect may then be regarded as having two pairs of maxillary palpi.

The maxillary palpi include from one to six pieces or joints. The labial palpi have from two to four. The intermediate piece, or tongue, is subject to great modifications. With the chin, it completes the buccal pieces.

In the licking and sucking insects the organs we have described are adapted to their new functions. Thus the tongue in bees reaches a great development; bugs, grasshoppers (Fig. 9), and lice have a long beak enveloping silky hairs, which form rudiments of jaws; in the butterflies we perceive a dispropor-

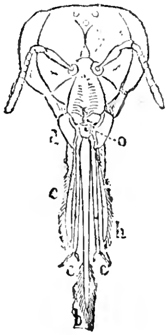


Fig. 8.

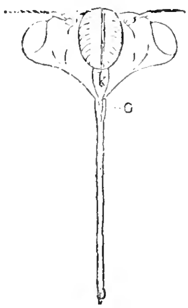


Fig. 9.

Fig. 10.

Fig. 8.—Mouth of a Bee. *b*, tongue; *c c*, labial palpi; *d*, mandibles; *e*, jaws; *h*, inner lobe; *o*, upper lip, or labrum.

Fig. 9.—Beak of a Grasshopper.

Fig. 10.—Trunk of a Butterfly.

tionately long proboscis; while in the *Diptera* the dispositions vary with the different groups. But in all these transformations the attentive observer will be able to perceive vestiges of the pieces comprising the mouth of the masticating insect which we have chosen as a type. These homologies were clearly established by De Savigny in 1816.

The eye and the head in vertebrates are movable. The visual rays consequently embrace a large horizon. The eye of the insect, on the contrary, is immovable, and solidly incased in the head; and the movements of the head itself are very limited. A great inferiority would result from this, had not Nature compensated for it by augmenting the circle of action of the eye itself. The insect's eye is formed by the union into a single mass of a considerable number of little eyes—sometimes exceeding twenty thousand (Fig. 11). Each of these minute organs, which are easily distinguished with a glass, comprises a hexagonal facet, representing the cornea; below this, a conical refracting mass represents the crystalline lens, and upon this abuts the nervous net emerging from the ganglion, which is itself in relation with the cerebral mass. The apparent part of the eyes is rounded, like a spherical cap, or rather like a portion of an ellipsoid. Sometimes the inner edge is indented like a bean, or like the kidneys of vertebrates. The eyes are then said to be reniform.

The organ of vision is sometimes made more complete by simple eyes, detached from the general group and permitting the insect to distinguish parts of space outside the field of the faceted eyes. These supplementary organs, called *ocelli*, usually three in number, are arranged triangularly between the reticulated eyes.

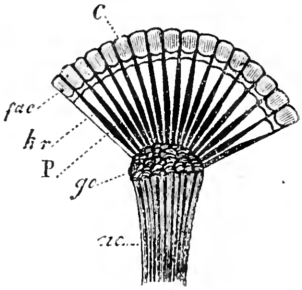


Fig. 11.—Section of an Insect's Eye. *C*, cornea; *fac*, cones; *hr*, rods; *P*, pigmentary sheathings of the rods; *go*, ganglion of the optic nerve; *no*, optic nerve. (According to Nuhn.)

The antennæ are articulated appendages which insects bear on the head, near the eyes, sometimes forward of them, sometimes behind them, and which are often greatly developed.

The antennæ are generally regarded as organs of touch; there is hardly any doubt about the fact. Some naturalists make them the seat of the smell; others consider them connected with hearing; and some locate both senses in them. However it may be, they are formed of a series of articulations united to one another, the number and form of which furnish entomologists with good characteristics for classification.

The antennæ are straight or bent. The basilar joint, which is in direct relation with the head, is called the scape; in bent antennæ it is usually very large, and forms an obtuse angle with the next joint. The club, or terminal part of the antenna, is sometimes in the shape of an olive, and is composed of a variable number of joints. The whole number of joints between the scape and the club constitutes the funicle. Characteristic forms of antennæ are represented in Fig. 12.

The thorax comprises three rings more or less closely joined: the prothorax, mesothorax, and metathorax. The prothorax bears the first pair of legs; it is largely developed in the *Coleoptera* and *Hemiptera*, in which it appears as a horny buckler, and is freely articulated with the mesothorax. It is the corselet of the old authors, and is called the *pronotum* by the entomologists of to-day.

The mesothorax bears the second pair of legs and the first pair of wings, which are sometimes horny; we perceive on the upper part of the insect only a small triangular portion of it, which is hardly visible in some species, and is called the *scutellum* or escutcheon. All the rest of the dorsal part is covered by the wings.

The metathorax is closely united to the preceding ring, and frequently also to the first rings of the abdomen. It bears the second pair of wings, which are always membranous when they are not atrophied, and the third pair of legs. The ventral part of the thorax is called the *sternum*, and the lateral pieces are the *epimera*.

The wings, usually four, are sometimes reduced to two, and may even disappear entirely, when the insect is said to be apterous. The two pairs of wings, when they exist, are unlike, as in the *Coleoptera* and bugs, or alike, as in the *Hymenoptera* and *Neuroptera*. When they are unlike, those of the first pair have a horny consistency. They form a protecting case for the wings of the second pair, and are called *elytra;* the wings of the second pair are membranous, and are supported only by a network of nerves, which forms a kind of framework for them. Of this character are the wings of the cockchafer and stag-beetle. In the elytrum we distinguish the base, or part adjacent to the prothorax; the shoulder, or fore-external part; the humeral callosity, a more or less pronounced lump near the shoulder; the suture, an inner part, by which the elytra at rest are in contact; the humeral angle, or external basilar angle (of the side of the shoulder); the scutellary angle, or inner basilar an-

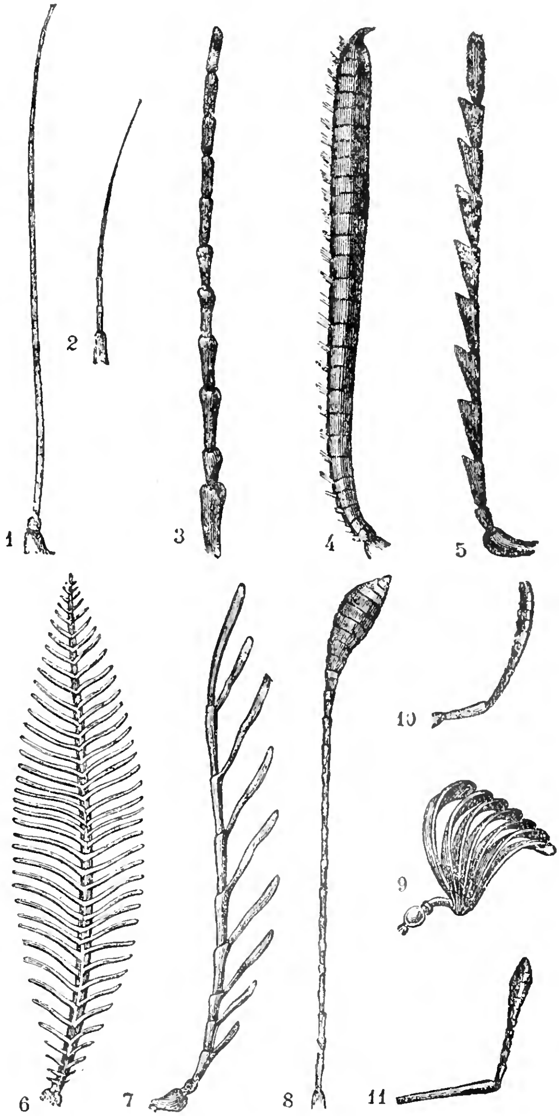


FIG. 12.—ANTENNÆ. 1. Setiform antenna. 2. Setaceous antenna. 3. Filiform. 4. Fusiform. 5. Serrated. 6. Pectinate. 7. Flabellate. 8. Clubbed. 9. Lamellated. 10 and 11. Bent.

gle (of the side of the escutcheon); the summit or extremity of the elytra; and the sutural angle, formed by the line of the suture with the outer edge at the summit of the elytra.

The elytra are not always entirely horny. In the heteropterous *Hemiptera*, the elytra remain membranous for a considerable extent near the summit. When the two pairs of wings are alike, both are membranous, and are constituted on the same plan as the wings of the second pair in *Coleoptera*. Of this character are the wings of the bee, the hornet, dragon-fly, and butterfly. The wings of the last are furthermore covered with brilliantly colored scales. The wings of the *Diptera* (flies, gnats, etc.), with their finely reticulated nervation, present the same membranous appearance; but the second pair are wanting, the only representatives left of them being small appendages known as balancers.

The legs are shaped for leaping (Fig. 13, A), for walking (B), or for swimming (C). Whatever may be their use, the general plan of their structure remains the same, and the modifications bear only upon one or the other of their constituent elements. Thus in the mole-cricket the legs of the first pair are adapted to digging the ground (D); those of the praying mantis (E F) are shaped like pincers; the lower leg, attached to the upper by a very supple joint, bends back upon it, as is shown in F, and forms with it a vise, the interior of which bristles with fine toothings suitable to hold captive any prey that may be taken.

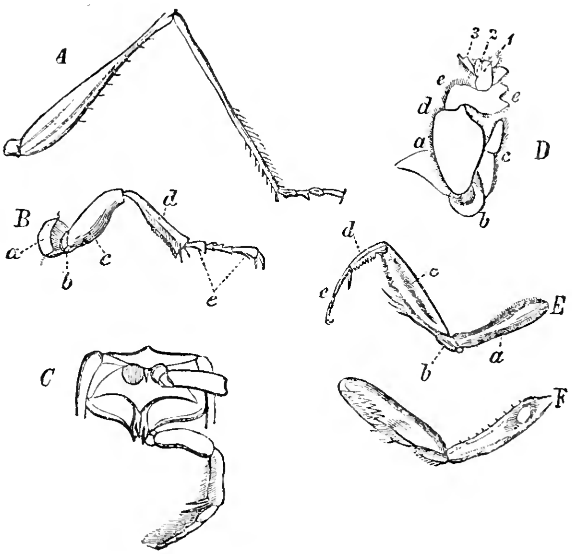


Fig. 13.—Different Forms of Legs.

What it has been agreed to call the leg of an insect comprehends the coxa (*a*), the trochanter (*b*), the femur (*c*), the lower leg or tibia (*d*), and the tarsus (*e*). The coxa is short, and is articulated into a cavity of the epimerum called the cotyloid cavity. The trochanter, which follows it, assists the movements of the femur joint. The femur is a strong lever which, in the case of insects organized for leaping, is considerably developed in the hinder legs (Fig. 13). The leg has the form of an elongated trapeze, the major base of which is often provided with spurs, while the crest is covered with teeth or rigid hairs. The tarsus is composed of joints, not exceeding and not always reaching five in number. These short joints are of different forms. They are sometimes furnished with fine balls of silk, a kind of brushes which aid in standing—or with suckers answering the same purpose. The last joint of the tarsus, called the *onychium*, bears one or two nails. The joints of the tarsi are generally distributed in equal numbers upon all the legs of the insect; but there are sometimes fewer on the middle and after limbs than on the fore limbs.

The arrangements we have pointed out hold with the walking insects; with aquatic insects the rugosities of the joints are smoothed down, the nails are blunted, and the legs are transformed into ciliated paddles that permit the animal to move easily in the water.

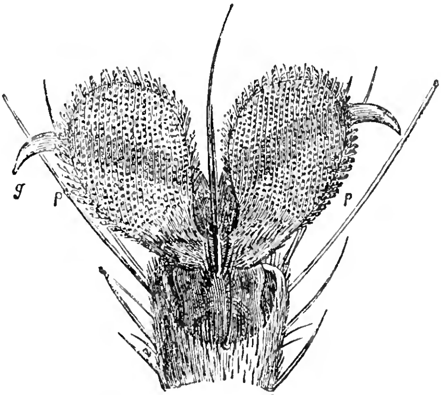


Fig. 14.—Foot of a Fly. *p*, pelotes; *g*, nails.

The abdomen consists of a series of rings joined to one another by a fine membrane which gives them great mobility. It is by means of this disposition that the abdomens of females when distended with eggs attain such extraordinary proportions. The number of abdominal segments varies from six to nine. The last ones are sometimes transformed into accessories of the genital apparatus. The last horny arch of the abdomen is called the *pygidium*, as in the tail of the cockchafer.

The cutaneous envelope of insects is usually of a dull, ruddy, or pitchy color; sometimes clearer, sometimes of a metallic appearance; but that which constitutes their richest livery is the investment of their external skeleton. This investment is formed of silks, felted hairs, spines, or thin caducous scales, the overlaying of which composes most original designs. A moderate enlargement is sufficient to give some species the appearance of brilliant jewels; seen under the lens, the *Curculio imperialis*, a Brazilian beetle, appears like a real set of emeralds and diamonds. Nothing is more interesting than to observe the fine pubescence of our native weevils and the delicate scales of the coats of some individuals. All these ornaments are, however, so fragile that we only have to graze a butterfly's wing with the finger to scatter all the chatoyant dust, and to lay bare the transparent membrane which it covered.

Some *Coleoptera*, as the *Larinus* and the *Polydrosus*, become unrecognizable when an awkward hand has stripped them of their magnificent raiment; the emerald robe and the curious designs disappear, to give place to the dark coloring of the teguments.

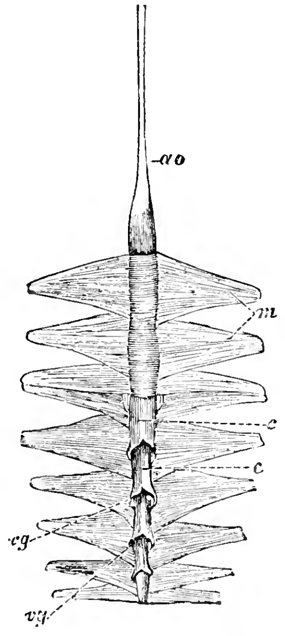


Fig. 15.—Circulatory Apparatus of the Cockchafer. *ao*, aorta; *c*, dorsal vessel; *m*, suspensory ligaments of the wings. (Straus-Durckheim, Anatomie comparée des animaux articulés.)

The circulatory apparatus of insects (Fig. 15) comprises a dorsal vessel (or heart), from which the ramifications start that distribute the life-giving fluid through the organization. The nervous network (Fig. 16) extends over the ventral face of the animal in the shape of two ganglionic cords which come together under the digestive tube to separate again into two branches. The latter embrace the œsophagus like a collar, and meet above it to inclose the cerebral mass.

As we have just seen, the nervous system is specially localized in the ventral region, while the seat of the circulatory apparatus is chiefly in the dorsal region. This is almost the exact contrary of what is remarked in vertebrates.

The digestive apparatus (Fig. 17) is situated between the circulatory and the nervous networks. The respiratory orifices, which give passage to the air, are distributed along the body. They are called *stigmata*. Upon them abut the tracheæ, tubes of an extreme tenuity, the interlacings of which branch out through the tissues.

The whole body of the insect is sensitive to touch, but the perception of sensations takes place chiefly by hairs in direct relation with the nervous system. These hairs are found more or less all over the creature, but particularly upon the antennæ and at the ends of the palpi.

The convenient arrangement of the eyes enables the insect to see all around itself without making any motion. The length of its view has not been precisely determined, but experiments seem to show that it is not great. The part played by the *ocelli* is also not clearly determined. In insects living in dark places, especially in those strangely shaped ones that live in caves, the organ of sight is atrophied, and is represented only by little swellings having the nervous filaments spread over their centers. These animals are not entirely insensible to the action of light; for they shrink from it and exhibit signs of being disagreeably affected when they are exposed to it.

The faculty of hearing is greatly developed among insects. The slightest noise disturbs them—yet the position of the organ of hearing has not been well defined. Maurice Girard* assumes that its seat is in the antennæ; and in the absence of a special organ, that it acts like a flexible rod, free at one end, and attached by the other end to an elastic membrane. M. Künckel agrees with Müller and Siebold that the organ of hearing is situated outside of the head.

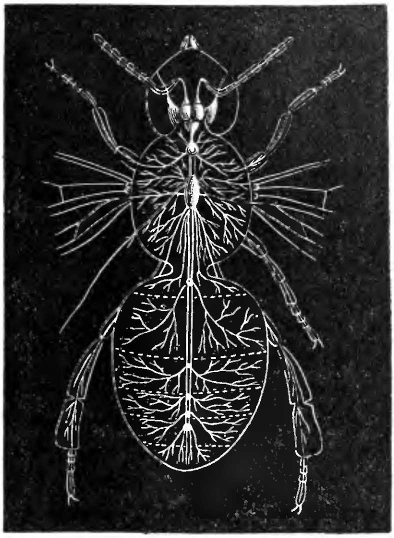


Fig. 16.—Nervous System of the Adult Bee. (After E. Blanchard, Metamorphoses.)

The smell and the taste, on the other hand, belong entirely to the cephalic region. The taste is seated near the mouth; the smell is one of the appanages of the antennæ. This has been irrefutably demonstrated by M. Balbiani, who, taking a number of newly hatched male silkworm moths, and isolating them from contact with females, divided them into two lots, which he placed in different boxes. One of the lots was left undisturbed, the other was subjected to experiments. The pectinal antennæ of all the individuals in it were cut off at the roots. On bringing tables on which were females near the boxes containing undisturbed moths, the insects were observed, even at a distance of several yards, to beat their wings and become violently agitated. But when females were brought near the moths that had been deprived of their antennæ, they showed no signs of being affected; their wings remained flat and motionless. The strong exhalations from the females were imperceptible to them; the removal of their antennæ had deprived them of the power of smelling.† Other naturalists, however, give the power of perceiving odors to the stigmata.

Locomotion is performed in insects, as in vertebrates, by means

* Maurice Girard, Traité d'Entomologie, comprising the history of useful species and their productions, and of injurious species and the means of destroying them.

† Brehm, Les Insectes. French edition, by J. Künckel d'Herculais. Paris: J. Baillière et fils.

of levers moved by muscles; but in the vertebrates the lever is within and the motor muscles are without, while in insects the muscles are inside and the lever outside. We have already pointed out the adaptation of the legs to the habits and the abode of the animals. The hairs with which the tarsi are furnished have a part in permitting flies to move on polished objects and to assist the rapid course of hydrometers, or skippers, on the surface of water. The wings sometimes come into play in propulsion on water; they are then furnished with long cilia, forming broad oars. The mechanism of flight has been the object of important studies by Pettigrew and Marey. A wasp, the ends of whose wings have been gilded, presents the appearance as shown in Fig. 19. The dispositions of the elytra of the *Coleoptera* during flight are extremely various. Poujade has given some interesting drawings of them in the annals of the Entomological Society of France. In them the cockchafer, the *Onthopagus*, is shown simply raising its elytra, the *Necrophorus* lifting them in a plane perpendicular to that of the body, and another genus holding them closed as in a position of rest. Sometimes, also, in moving through the air, the middle legs are raised above the body.

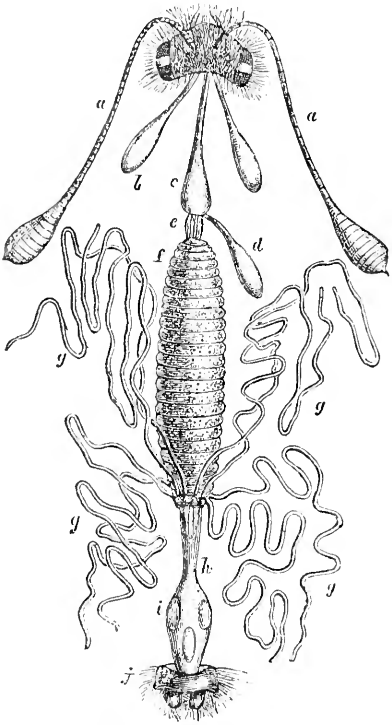


Fig. 17.—Digestive Apparatus of a Sucking Insect (*Ascalaphus meridionalis*). *a a*, antennæ; *b*, salivary glands; *c*, œsophagus; *d*, stomach; *e*, gizzard; *f*, chylific ventricle; *g g*, tubes of Malpighi; *h*, intestine; *i*, rectum; *j*, last segment of the abdomen. (After Léon Dufour.)

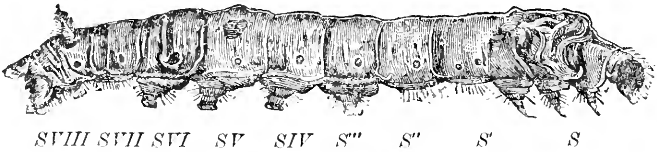


Fig. 18.—Disposition of the Stigmata of a Silk-worm. *S*, stigmata of the first ring; *S'*, stigmata of the fourth ring; *S''* to *SVIII*, stigmata situated on the fifth, sixth, and eleventh rings.

A considerable number of insects secrete products, some of which are useful, while others are injurious. First in order among useful secretions are silk and wax. Silk is furnished more or less abundantly by all the caterpillars and many other larvæ. The silkworms produce it in large quantities.* Wax is produced by a number of *Hymenoptera*, which construct cells of it to hold honey. Aphides and cochineals secrete fatty matters, the white tufts of which form a kind of down on their bodies and on the plants they frequent. In other insects the secretions become a defensive armor. Thus the *Hymenoptera* drop poison in the wound made in animal tissues by their sting, which it causes to swell. An analogous stinging gives rise to the excrescences called galls, with which the leaves of trees are

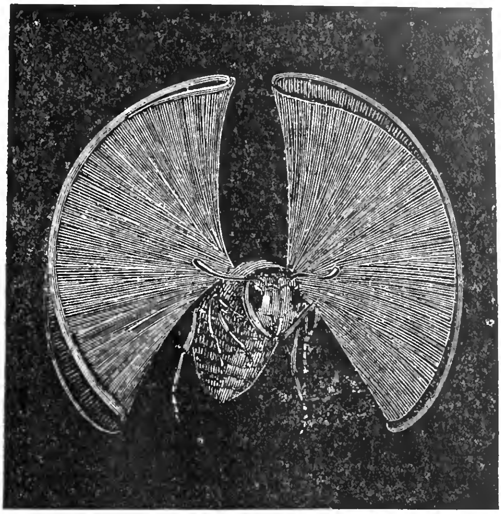


FIG. 19.—APPEARANCE OF A WASP IN FLIGHT.

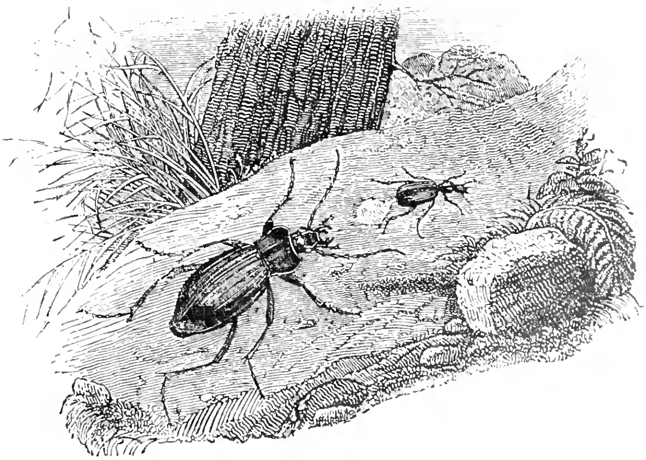


FIG. 20.—SCAPHINUS REPELLING THE ATTACK OF A CARABUS.

often covered. Many of the *Coleoptera* emit penetrating odors. The *Cicindela* smells of the rose, the *Aromia moschata* of musk; the anal glands of the carabicus produce butyric acid; while

* See Leo Vignon, La Soie au point de vue scientifique et industriel. Paris, 1890 (Bibliothèque des Connaissances utiles).

some of these *Coleoptera* eject by the anus a caustic liquid which, vaporizing suddenly, detonates with intensity, like an explosive; whence the *Brachini* have been called bombarders.

THE PEARL OF PRACTICE.

By ELIZABETH ROBINSON.

THE Wakefield family have always been very proud of tracing their descent from an old English doctor who came to this country in the latter part of the seventeenth century. Proudly they show the various relics of this highly respected ancestor—his old battered silver snuff-box, with dim, worn inscription, telling that it was a gift from a scion of nobility, who thus rewarded his medical man for service done in his cause; the comical night-cap which once covered the dear doctor's revered head, a pair of shoe-buckles, a few buttons from his small-clothes, and last, but not least, an old account-book and book of prescriptions. The account-book opens of itself at the pages where noble names are most often inscribed: "A purge for Lady Mary Brown"; an emetic (the good doctor uses a more Shakespearean word) for Lady Betty Smith, a draught for this lord, a blister for that, etc.

We turn with due consideration the thin, yellow pages, covered with fine, faded writing, still perfectly legible, queerly spelled. The book of prescriptions, The Pearl of Practice, is so old, so near dropping in pieces, that it surely has to be taken up tenderly, handled with care. It has every appearance of great age, and we are not surprised to learn that it was printed in London two hundred and seven years ago. The ancient volume shows evidence of much consultation. We open it with respect, which quickly turns to righteous horror and indignation as we peruse the crumbling pages. We can only hope that this venerated disciple of Æsculapius practiced mostly in his own country, and did not work fell disaster in the struggling colonies of America. Truly British brawn and the accessory of England's climate were needed even for the "survival of the fittest" if many of these strange and wonderful prescriptions were followed. Even so early in our history the Americans were far too "nervous" to bear many such heroic doses, even if the true nature of the ingredients could have been concealed. Perhaps we have always had a leaning toward the "new school" of medicine; a little study of these old pages quite convinced us of it. But we fancy the most conservative physician of the "old school" to-day would not go very far by this queer little book.

In the first place, one would have to be the happy possessor of an independent fortune to be able to compound many of the remedies; no drug-store would carry such expensive materials. "Amber-greece," pearls, coral, and gold were in as common use then as quinine has been during the recent reign of *la grippe.*

The following powder comes in the list of "Choice Physical and Chirurgical Receipts." We are not told in what disease or diseases it is warranted to kill or cure. A "universal remedy," mayhap; should judge it to be powerful:

"*The Bishop of Worcester's admirably curing Powder.*—Take black tips of Crabs' claws when the Sun enters into *Cancer,* which is every year on the eleventh day of *June;* pick and wash them clean, and beat them into fine powder, which finely searce; then take Musk and Civet, of each three grains, Amber-greece twelve grains, rub them in the bottom of the Mortar, and then beat them and the powder of the Claws together; then with a pound of this powder mix one ounce of the magistery of Pearl.* Then take ten skins of Adders, or Snakes, or Slow-worms, cut them in pieces and put them into a pipkin to a pint and a half of Spring-water; cover it close, and set it on a gentle fire to simmer only, not to boyl, for ten or twelve hours, in which time it will be turned into Jelly, and therewith make the said powder into balls.

"If such skins are not to be gotten, then take six ounces of shaved Harts-horn, and boyl it to a jelly, and therewith make the said powder into balls; the horn must be of a red Deer killed in *August,* when the Moon is in *Leo,* for that is best.

"The Dose is seven or eight grains in beer or wine."

There are many references to "the Plague," from "an excellent perfume against the Plague," to strange drinks and medicines to be used both before and after "infection." We will give the oldest receipt first:

"*A Drink for the Plague or Pestilent Fever, proved by the Countess of Arundel, in the Year 1603.*—Take a pint of Malmsey, and burn it, and put thereto a spoonful of grains, being bruised, and take four spoonfuls of the same in a Porringer, and put therein a spoonful of Jean Treacle, and give the Patient to drink as hot as he can suffer it, and let him drink a draught of the Malmsey after it, and so sweat: if he be vehemently infected he will bring the Medicine up again; but you must apply the same very often day and night till he brook it, for so long as he doth

* "*To make true Magistery of Pearl.*—Dissolve two or three ounces of fine seed Pearl in distilled Vinegar, and when it is perfectly dissolved, and all taken up, pour the Vinegar into a clean glass bason; then drop some few drops of Oyl of Tartar upon it, and it will cast down the Pearl into fine powder, then pour the Vinegar clean off softly, then put to the Pearl clear Conduit or Spring water; pour that off and do so often until the taste of the Vinegar and Tartar be clean gone, then dry the powder of Pearl upon warm embers and keep it for your use."

bring it up again there is danger of him; but, if he once brook it, there is no doubt of his recovery by the Grace of God; provided then when the party infected hath taken the aforesaid Medicine and sweateth, if he bring it up again then you must give him the aforesaid quantity of Malmsey and grains, but no Treacle, for it will be too hot for him, being in a sweat. This Medicine is proved, and the party hath recovered, and the sheets have been found full of blew marks, and no sore hath come forth; this being taken in the beginning of the sickness. Also this medicine saved thirty-eight Commons of Windsor the last great Plague 1593, was proved on many poor people, and they recovered."

In "The King's Medicine for the Plague," a very simple herb drink, one is assured that after taking it the first day "you shall be safe four-and-twenty days, after the ninth day a whole year by the grace of God." This next remedy for the plague would hardly be found available in a great city; the poor people of plague-stricken London were, one fears, never able to profit by it, as it calls for wholesale slaughter, not of the innocents, but of as harmless feathered bipeds. "Mr. Winlour," whoever he may be, who found this prescription so effectual, was no doubt a suburban gentleman with cock-chicks galore at his command:

"*A Medicine for the Plague which the Lord Mayor had from the Queen.*—Take of Sage, Elder, and red Bramble leaves, of each one little handful; stamp and strain them together through a cloath with a quart of White-wine; then take a quantity of White-wine-Vinegar, and mingle them together; and drink thereof morning and night a spoonful at a time nine days together, and you shall be whole. There is no medicine more excellent than this, when the sore doth appeare, than to take a Cock-chick and pull it, and let the Rump be bare, and hold the Rump of the said Chick to the sore, and it will gape and labour for life and in the end die; then take another, and the third, and so long as any one do dye; for when the poyson is quite drawn out the Chick will live, the sore presently will assuage, and the party recover. *Mr. Winlour* proved this upon one of his own Children, the thirteenth Chick dyed, the fourteenth lived, and the party cured."

Cock-chicks, especially "running" ones, were in great demand in those bygone days; they enter into the composition of many of these "excellent receipts" either in an active or passive state.

"*Cock-water for a Consumption.*—Take a running Cock-chick, pull him alive, then kill him, cut him abroad by the back, take out the entrails and wipe him clean, then quarter him and break his bones, then put him into a Rose-Water Still with a pottle of Sack, Currans, and raisins of the Sun stoned, and figs sliced, of each one pound, Dates stoned and cut small half a pound, Rosemary

Flowers, Wild Time, Spearmint, of each one handful, Organs or wild Marjoram, Bugeloss, Pimpinel, of each two handfuls, and a pottle of new milk from a red Cow. Distill these with a soft fire, put in the Receiver a quarter of a pound of brown Sugar candy beaten small, four grains of Amber-greece, forty grains of prepared Pearl, and half a book of leaf gold cut very small; you must mingle the strong water with the small, and let the Patient take two spoonfuls of it in the morning and as much at going to bed."

Although this precious Pearl of Practice was published more than fifty years before Mark Twain's Majestic Literary Fossil, the virtues of "*Aqua Limacum*" (in this treasure called "A Special Water for a Consumption") were well known even at that early age. Delicious compound! most truly strengthening and reviving, with its "peck of garden shell snails" bruised in a mortar, shells and all, quart of earth-worms "ripped up" and "scoured with salt," combined and distilled with herbs too numerous to give here. Horrors!

One would surely prefer some of the greatly advertised "emulsions" of the present century. We can not believe that such slow creatures as snails were ever very common in the "rapid" life of America. So we trust that our beloved forebears were not dosed with many snail elixirs. One might consent to their use in "anointing," but draw the line at drinking their juices.

"*To Anoint the Ricketed Child's Limbs, and to recover it in a short time, though the Child be so lame as to go upon Crutches.*—Take a peck of Garden Snails and bruise them, put them in a coarse Canvas Bag, and hang it up, and set a dish under it to receive the liquor that droppeth from them, therewith anoint the Child in every joynt which you perceive to be weak, before the fire every morning and evening. This I have known make a Child that was extream weak to go alone, using it only a weeks time."

By the many receipts given for curious oyls, plaisters, oyntments, and salves, one judges that the efficacy of "outward applications" was seldom called in question.

"Oyl of Swallows" attracts one's attention; it would be very hard to "make." What kind of swallows? where could one find them, and how catch them? "Take Swallows as many as you can get, ten or twelve at least, and put them quick into a Mortar." Alive or dead? feathers and all? we query. Unto these "pounded" swallows are added many herbs and spices. "Neat's-foot Oyl or May butter," much "wax and a pint of Sellet-Oyl," the whole mess strained through a canvas cloth. Truly a fine oil for divers complaints. From the salves we of course choose the "chief," and one we must believe used by nobility if not royalty:

"*Sir Edward Tertil's Salve called the chief of all salves.*—Take Rosin eight ounces, Virgins wax and Frankincense, of each four ounces, Mastick one ounce, Harts suet four ounces, Camphire two Drams, beat the Rosin, Mastick and Frankincense in a Mortar together to fine powder; then melt the Rosin and Wax together, then put in the powders; and when they are well melted strain it through a cloath into a pottle of white Wine, and boyl it together till it be somewhat thick; then let it cool, and put in the Camphire and four ounces of Venice Turpentine drop by drop, lest it clumper, stirring it continually, then make it up into Rolls, and do with it to the pleasure of God, and health of man.

"*The Vertues and use of it:* 1. It is good for all wounds and sores old or new, in any place. 2. It cleanseth all Festers in the flesh, and heals more in nine days than other salves cure in a month. 3. It suffers no dead flesh to engender or abide where it comes. 4. It cureth the Head-ach, rubbing the Temples therewith. 5. It cures a salt fleam Face. 6. It helpeth Sinews that grow stiff, or spring with labour, or wax dry for want of blood. 7. It draweth out rusty Iron, Arrow heads, Stubs, Splints, Thorns, or whatever is fixed in the flesh or wound. 8. It cureth the biting of a mad Dog, or pricking of any venomous creatures. 9. It cureth all Felons or white-flaws. 10. It is good for all festering Cankers. 11. It helpeth all Aches of the Liver, Spleen, Kidneys, Back, Sides, Arms or Legs. 12. It cureth Biles, Blanes, Botches, Imposthumes, Swellings, and Tumors in any part of the body. 13. It cureth Scab, Itch, Wrenches, Sprains, Strains, Gouts, Paulsies, Dropsies, and waters between the flesh and skin. 14. It healeth the Hemorrhoids or Piles in Man or Woman. 15. Make a search-cloth thereof to heal all the above-said Maladies, with very many others which for brevity sake are omitted."

A "Balsam" of use for infected brains may appeal to the overtaxed student:

"*To cure Diseases without taking anything at the mouth.*—Take one pound of Aloes Hepatica, Myrrhe four ounces, both beaten very fine, *Aquavitæ* and Rose-water, of each one pint; after one nights infusion distill them in Sand twenty four hours very softly, and in the end make a great fire, and there will come a Balsam wherewith if you rub the Stomach with a warm cloath dipped therein, it will Purge Phlegm and Choler, and all worms which infect the brain, and breed the Falling-sickness, it expelleth corruption of the Stomach, it helps digestion and appetite, it expurgeth all dross in the bottom of the Stomach, it cureth the Gout being mixed and well beaten with *Aquavitæ*, and applyed warm to the Gouty place and left long on it."

Here is a genuine faith-cure of "y^e^ olden time," though for that matter most of these ancient prescriptions require faith as well as courage in the patients partaking of the strange admixtures:

"*To cure a Wound, though the Patient be ever so far off.*—Take a quart of pure Spring water, and put into it some Roman Vitrol and let it dissolve, then if you have any blood of the wound either in linnen or wollen or silk, put the cloth so blooded into the water, and rub the cloth once a day, and if the wound be not mortal, the blood will out, if it be, it will not. Let the Patient keep his wound clean, washing it with white wine; when ever you wash the cloth, the Party wounded shall sensibly find ease; let the cloth be constantly in the water."

One is hardly surprised to find, among the other horrors in these medicinal compounds, that "dung" of various and sundry kinds plays an important part. Read this rare combination of game and fertilizing materials, in juxtaposition with the household "staff of life":

"*Dr. Baffa, an Italian. An approved Receipt to break the Stone in the Kidneys.*—In the Month of May distill Cowdung, then take two live Hares, and strangle them in their blood; then take one of them, and put it into an earthen vessel or pot, and cover it well with a mortar made of Horsedung and Hay, and bake it in an Oven with household bread, and set it still in the Oven for two or three days, baking it anew with anything, until the Hare be baked or dryed to powder; then beat it well, and keep it for your use. The other Hare you must flea, and take out the guts only; then distill all the rest, and keep this water; then take at the new and full of the Moon, or any other time, three mornings together as much of this powder as will lie on a sixpence, with two spoonfuls of each water, and it will break any stone in the Kidneys."

Then this "pretty" drink:

"*The Lady Gorings Water for an Ague, sickness or foulness in the Stomach, and to purge the blood.*—Take dung of a stone-horse that is kept in the stable, when it is new made, mingle it well with Beer and a little Ginger, and a good quantity of Treacle, and distill in an ordinary still; give of this a pretty draught to drink."

Truly loathsome, perfectly disgusting, we say; "reely nasty," "beastly," perhaps our English cousins said.

We often hear people complain of the elongation of the palate (uvula), and they have recourse to many remedies, surgical and otherwise; even if one could believe that the uvula could be affected from the top of the head, through skull, brains, and all, would the "cure" here given work on a thick head of hair, or is it only applicable to the bald-headed?

"*To draw up the Uvula.*—Take a new-laid Egg, and roast it till it be blue, and then crush it between a cloath, and lay it to the

Crown of the Head, and once in twelve hours lay new till it be drawn up."

"*Dr. Adrian Gilbert's most Soveraign Cordial Water*" contains, among other things too numerous to mention, from one to two pounds each of thirty-nine different plants, "two pounds of shaved Hartshorn, twelve ounces of Ivory, a goodly quantity of Clarret wine and best Malaga Sack," all distilled.

When small-pox, plague, spotted fevers, and ordinary fevers are abroad in the land, "if one take, in time of infection, two spoonfuls of this Cordial water in good Beer or white Wine he may safely walk from danger by the leave of God."

Another "*Soveraign Water*" of Dr. Stephens's, "which he a long time used, wherewith he did many cures; he kept it secretly till a little before his death, and then he gave it to the Lord Arch-Bishop of Canterbury, in writing." It does not differ greatly from the preceding, but oh the virtues of it!

"*The Virtues of this Water.*—It comforts the Vital Spirits, and helps all inward Diseases that come of cold; it is good against the shaking of the Palsie; it cures the contraction of the Sinews; it kills the Worms in the Belly and Stomach; it cures the cold Dropsie, and helps the Stone in the Bladder, and in Reins of the Back; it helps shortly the stinking breath, and whosoever useth this Water morning and evening (and not too often) it preserveth him in good liking and will make him seem young very long, and comforteth Nature marvelously; with this water did Mr. Stephens preserve his life till extreme age would not let him *go or stand;* and he continued five years when all the Physicians judged he would not live a year longer, nor did he use any other Medicine but this."

Another "*Aqua Mirabilis, Sir Kenelm Digby's way,*" is more simple in build but as wonderful in effect.—"This water preserveth the Lungs without grievances, and helpeth them; being wounded, it suffereth not the blood to putrifie, but multiplyeth the same; this water suffereth not the heart to burn, nor Melancholy, nor the Spleen to be lifted up above nature; it expelleth the Rhume, preserveth the Stomach, Conserveth youth, and procureth a good colour; it preserveth memory; it destroyeth the palsie; if this be given to one a dying, a spoonful of it reviveth him; in the Summer use one spoonful a week fasting, in the Winter two spoonfuls."

If one can judge by the number of prescriptions given, small-pox was more common two hundred years ago than measles now. "Megrims," "melancholy fumes," "fainting of the heart," "passion" of the same, were as well known as the "nervous prostration" of these later days.

We fail to see the true meaning in the title of the receipt next in order. Does the patient (poor victim!) or the mixture of long-named ingredients "hum"? And why "damnable"?

"*A Receipt to make Damnable Hum.*—Take spices de Gemmis Aromaticum Rofatum, Diarrhodon Abbatis, Letificans Galeni, of each four drams, Loaf-sugar beaten to a powder half a pound, small Aqua Vitæ three pints, strong Angelica water one pint; mix all these together, and when you have drunk it to the Dregs, you may fill it up again with the same quantity of water. The same powders will serve twice, and after using it it must be made new again."

Some of the receipts have been "proved"; for instance:

"*The Lady Drury's Medicine for the Colick, Proved.*—Take a turf of green grass, and lay it to the Navil, and let it lye till you find ease, the green side must be laid next to the belly."

Another was "Proved by Mrs. Joyce, Widow."

We must finish our study of this most fascinating, quaint little leather-bound volume; but a strange title attracts us here, a stranger ingredient there, and it is hard to stop—for example: "A very good glyster for the Wind." "Syrup of Turnips." "A purging Juleb." "A Vomit for an Ague." "A Cordial Electuary for Stuffing of the Stomach." "For a Noli me tangere." "For pin and web in the eye."

Scraped amber taken in hot broth is a truly "precious" draught for fainting.

For stomach-ache one is told to cut "scarlet" into the shape of a heart, wet it in strongest cinnamon or wormwood water, heat it, and lay very hot to the stomach.

"The Claws of a Goat burned to Powder"; "Unicorns-horn"; "Blue Lilly roots"; "Woodlice, dried, and made into fine powder"—all to be taken internally! Split salt herrings applied to the feet in fever.

Let us be thankful that we live in this nineteenth century, albeit one of multitudinous patent medicines, hypnotism, Christian science, and magnetic and electric remedies. We humbly trust that what little medicine we are forced to take will better bear analyzing than the strange pharmaceutical compositions of animal, vegetable, and mineral matters gleaned from the Wakefield heirloom. We return this treasure with many thanks. It is eagerly seized and quickly locked up in the grandfather's desk almost as ancient as itself. We are assured that it is regarded as a priceless "Pearl," and worth more to its owners (from its antiquity and associations rather than its intrinsic value, we suppose) than its weight many times over in purest gold.

THE FUTURE OF THE DRY LAND.*

By M. A. de L'APPARENT.

I PURPOSE to inquire briefly into the probable future of the dry land, to ask if it is not destined to disappear, and to estimate the time that may be required to execute a sentence of extinction against it. It would have been hazardous to touch upon this question a few years ago. Precise data were wanting as to both the value of the relief of the land and the intensity of the actions which are called into play to change it. But the progress of geographical study has now put us in possession of more exact information, enough to permit us to seek a solution of the problem, not in the expectation of getting exact figures, but of calculating approximately the magnitude of the effects which we have to contemplate.

The labors of geographers in later years have given us a much more complete knowledge than we had before of the land relief. Ten years ago we still accepted Humboldt's estimate that, if all the asperities of the land were leveled over its entire surface, the resultant plateau would stand 305 metres above the surface of the sea. This figure began to grow perceptibly about 1880. A German student, Herr Krümmel, raised it to 444 metres. A few years ago, I thought it best, in preparing the chapter in my Traité de Géologie bearing upon this subject, to go into new calculations on the basis of existing hypsometric maps, and I came to the conclusion that the mean altitude of the dry land would be more than 500 metres, and would probably approach 600 metres. I declared this result with some reserve, on account of its novelty. But I had the satisfaction of seeing it immediately accepted by foreign geographers, and my estimates have since been exceeded; for Messrs. John Murray, Penck, Supan, and De Tillo, having been able, by the aid of the cartographic documents accessible to them, to make still more precise calculations, have found that the land relief may be represented by a uniform plateau rising to 700 metres above the level of the sea.

This plateau of 700 metres is the object of incessant attacks by the ocean on one side and atmospheric agents on the other. The rivers never cease carrying to the sea the fine fragments of the rocks which the rain washes into them, after they have been disintegrated by the alternate actions of moisture and drought, cold and heat, freezing and thawing. By observation of what takes place at the mouths of rivers, we may succeed in reaching a clear idea of the measure in which the silent action of atmospheric agents

* Address before the Geographical Society of Paris.

pares away the continental masses. Mr. J. Murray, of Scotland, from the study of all that has been published on this subject, of which he has himself furnished a considerable proportion, has found that the outflow of the nineteen principal rivers of the earth is 3,610 cubic kilometres a year. These 3,610 cubic kilometres bring to the sea a mass of solid matter in suspension equivalent to one cubic kilometre and $\frac{385}{1000}$, making a proportion in value of 38 parts per 100,000. On the other hand, meteorological observations have become precise enough to enable us to estimate approximately the annual outflow of all the rivers of the earth. Mr. Murray puts it at 23,000 cubic kilometres. Applying to this figure the same proportion of 38 per 100,000, we get, for the amount of solid matter annually carried mechanically to the sea by rivers, 1,043 cubic kilometres. That is the effect of the mechanical action of the continental waters.

What part do the waves of the ocean take in this action? When we hear the noise of the waves breaking against the bluffs and throwing their grape-shot of pebbles against them, and when we witness the enormous land-slides of which the sea-shores are often the theatre, we are sometimes led to think that the action of the sea is a preponderant factor in the destruction of continents. But the reverse is the case.

England may be regarded as one of the countries in which attacks by the sea upon the coast are most intense; for the waves of the Atlantic are thrown very violently against the shore by the southwest winds. English geologists appear to be agreed in thinking that the waste of the coasts of Britain under the action of the sea is certainly not more than three metres a century. It is true that at certain points of the French littoral, as at Havre, the banks are estimated to lose a quarter of a metre a year. M. Bouquet de la Grye raises the loss to a little more than a metre a year on the limestone coasts of the southwest; but, in compensation, there are seas where the work of the waves may be neglected as null, as well as flat coasts, where the sea, building up littoral bars, adds instead of taking away. I believe, then, till the contrary is proved, that if we allow for the whole earth a waste of three metres in a hundred years, we are above rather than below the truth.

If we suppose that the shore-banks average fifty metres in height, it follows that an annual waste of three centimetres will remove a cubic metre and a half per running metre, or 1,500 cubic metres per kilometre. The extent of the sea-coasts of the earth can be easily calculated with the aid of the figures given in Elisée Reclus's Continents, showing the proportion, in each continental unit, of dry-land surface and extent of coast-line. Applying these figures to those which represent the surface, now well known, of the different countries, we get 200,000 kilometres as the total length of the coast-lines. Hence, the supposed loss of 1,500 cubic metres per kilometre per year would give 300,000,000 cubic metres, or three tenths of a cubic kilometre. Thus, while the running waters take away ten and a half kilometres, the sea does not remove one twentieth of that quantity. Even supposing I have underestimated the height of the coast-banks, and have not given enough importance to the annual waste, let the figures I have used as the base of my calculations be tripled, we still find the effect of sea action a mere fraction, hardly significant, of that which is produced by the silent wash of the rivers. We can say here, as in many other cases, that what does the most work is not that which makes the most noise.

We have, in addition to this, to consider the solvent action of continental waters. They partially dissolve all the rocks, aided, as they are in the action, by carbonic acid; and they come to the sea charged with a considerably larger proportion of matter in solution than one would at first be liable to suppose. According to the labors of the English, American, and International commissions, which have especially studied the composition of the waters of rivers, particularly of the Mississippi, Danube, and Thames, the quantity of solid matters brought down in solution from the continents is not less than five cubic kilometres a year. This, added to the matter carried down mechanically, gives about $15\frac{1}{2}$ cubic kilometres, or, including the results of marine action, 16 cubic kilometres. This, then, is about what the continental masses lose each year.

Let us consider this supposed uniform plateau standing up 700 metres above the level of the sea. By the operation of the circumstances of which I have spoken, 16 cubic kilometres are taken from this mass every year. The continental surfaces covering 146,000,000 square kilometres, we calculate that a waste of 16 cubic kilometres will remove, each year, a layer $\frac{11}{100}$ of a millimetre thick. The *débris* from this layer will settle on the bottom of the sea and assume the form of sedimentary deposits; they will take the place, then, of a corresponding quantity of water, in consequence of which the sea will rise to a certain extent. The ratio of the continental surface being to that of the seas about as 100 to 252, the total result will be a lowering of the height of the plateau of about $\frac{155}{1000}$ of a millimetre every year.

As many times as this $\frac{155}{1000}$ of a millimetre is contained in 700 metres, or 700,000 millimetres, so many years will be required to bring about the disappearance of the dry land. Make the calculation, supposing the present intensity in the phenomena of destruction to continue, and you will find that it will take 4,500,000 years to wear the surface of the earth entirely away. This may be a reassuring figure to us. But the geologist, who looks at the past as well as at the future, far beyond existing generations, can draw more than one lesson from it. First, the whole history of the globe not being included in a space of time relatively so short, the result teaches us that its equilibrium has more than once been troubled by great phenomena of dislocation, too rare, however, for it to be possible for man to have been a witness of them, which, building up new reliefs as barriers to destruction, have given new impulses to the action of natural forces.

On the other hand, geological observations furnish a tolerably approximate measure of the maximum thickness of the deposits that are made in the bottom of the sea. The total thickness amounts, according to Dana, to 45,000 metres. To learn how long a time may have been occupied with the formation of such deposits, let us seek to represent to ourselves what now becomes of the products of the destruction of the continents.

These deposits, it is now known, do not extend, by a great deal, over the whole surface of the sea bottom; but they form a zone of strata which the deep-sea sounding expeditions have enabled us to define fairly well. According to Mr. John Murray's estimate, the sediments formed by the destruction of the continents spread themselves over about a fifth of the oceanic surface. Thus, although the oceanic area is superior to the surface of the land, the mass of the deposits distributing themselves over only a fraction of the extent, there may result, at the end of 5,000,000 years, an accumulation of sediments capable of forming a body 750 metres thick. But this thickness would certainly be very unevenly distributed; almost null at the finishing point of the deposits in breadth, its thickness would be much greater near the coasts, and it would not be hazardous to suppose that it might rise there to 2,000 or 3,000 metres. To realize the total thickness of 45,000 metres—that is, to explain geological history—it would be sufficient to suppose that the life of the globe has included some fifteen or twenty periods of 4,500,000 years, or from 67,000,000 to 90,000,000 years, a number a little less than the 100,000,000 years which Sir William Thomson has calculated upon estimates of the loss of internal heat.

The objection may be brought up that I have neglected in this calculation the contributions of volcanic action to the land relief, which it is thought should be counted in attenuation of the destructive effect of running waters. We owe to Cordier a calculation that the lavas which have been thrown up during the historical period represent at most 500 cubic kilometres, or, counting that period at 3,000 years, a sixth of a cubic kilometre per year. This is a very little affair compared with the amount of the waste which I have pointed out. We should likewise recollect that besides eruptions there are also volcanic explosions like those which our generation has witnessed at Krakatoa in 1883, Bangtaisom in 1887, and which our fathers observed at Temboro in 1832. If we reflect that the explosion of Krakatoa threw 16 cubic kilometres of matter into the air, and that of Temboro was still more considerable, we may be permitted to say that volcanic action, instead of diminishing, adds to the constant degradation of the continental relief.

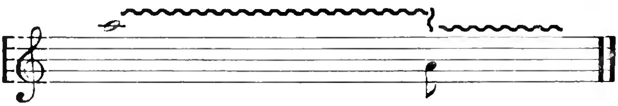
I have not assumed to give precise figures on this subject. My object is less to exhibit numerical results than to present a view of the relative magnitude of the effects under analysis. It is evident that these effects can not be neglected, and that they permit us to assign to the geological history of our globe a duration less than the somewhat fantastic figures to which we have been occasionally asked to give credit.

It is nevertheless true that the disappearance of the continental relief, while it may receive the attention of the geologist and thinker, is not one of those events concerning which present generations need trouble themselves. Neither our children nor our great-grandchildren will have a visible prospect of it presented to them as an actual danger.—*Translated for the Popular Science Monthly from Ciel et Terre.*

THE MUSIC OF THE BIRDS.

By SIMEON PEASE CHENEY.

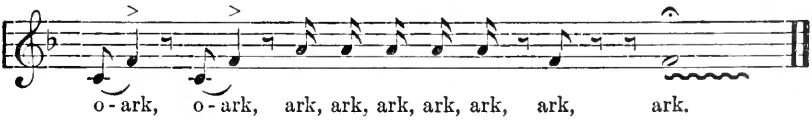
HEN MUSIC.—Late, one night, as I chanced near the hennery with a light, I was rewarded by an exquisite exhibition of the communicative ability of our domestic fowls. The hens moved on their perches; when the rooster spoke, rousing them still more. Stepping back, I soon heard a little sound, high and "exceeding fine," with a deceiving, ventriloquous quality. Long spun, and then bent down in a graceful descent of the interval of a sixth, it terminated in a more decided tone, a peculiar tremor something less than a trill, and died away in a beautiful diminish:



This model example in *pianissimo* practice, and in the art of holding the breath, proved to come from one of the hens; and, though the exact tones are here represented, no idea can be conveyed of the unique, perfect performance. The quieting effect on the family was instantaneous; not another move or peep. The descent noted is similar to that made by the screech-owl. The intervals are identical; but the hen slides down with an oily smoothness, while the owl, as elsewhere shown, comes trembling, shivering down.

Being an hour late with their breakfast one morning, I was received by the feathered supplicants with unusual demonstrations. They crowded about me so closely I could hardly step without treading on their toes. With heads lifted much higher than one would think they could be, and eyes shining, their tones and inflections were exceedingly human. Like all birds, wild or tame, hens employ, ascending and descending, the intervals of our scale, except in cases as above described; they use the half-step and whole step, the major and minor thirds, the fourth, fifth, and sixth, with a good sprinkling of chromatics. In this instance, every degree of the staff was brought into requisition, the slide of a fourth upward occurring oftenest.

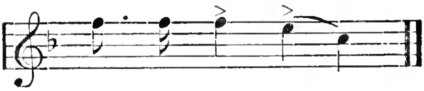
The notes of one hen were all the same, and *piano:*



But the rooster's petition "led all the rest." Striding about in the rear, an occasional brief command attesting his title of "captain," at length he burst out into this sonorous strain:

The captain's voice was round and powerful, and his intonation perfect. The slides of the third and fourth were carried up with a noble *crescendo;* and, when he rose to the tonic at the close, the effect was thrilling as that of a clarion blast. What with his sturdy song and dignified, soldierly bearing, the captain's effort was full of hints, in manner and motive, for the composer, the singer, and the orator. When, a few mornings after his notable improvisation, I found the captain's lifeless body, I was not surprised at the gentle demeanor of his many widows; they felt, perhaps more keenly than I, that one of the mighty had fallen.

It was several weeks before I found a substitute for the captain; at length a boy brought him, and I saw at a glance that he was the "general." With a word or two by way of greeting, he paused and stood erect before the bereft hens. Soon a pullet, the only shy member of the company, ran to him and put her head close to his. If the general moved, Ruth-like, she moved. A mourner of wider experience was no less interesting in behavior. For some moments she stood aloof in disgust; then, with more ruffle at her neck than was becoming, flew at the general with all fury. The astonished soldier returned several blows, then, checking himself, held his head to the ground, covered with confusion. The fair insulter had no idea of quitting; she continued the onslaught, finally ending it with a series of smart picks square on the lordly comb. The general "grinned and bore it," and thus ended the ludicrous mistake; for a mistake it was, the general fancying for an instant that he was dealing with a foeman worthy of his spur. On discovering his blunder, he was glad to suffer the most crushing humiliation. The newcomer proved a lusty crower; and, after taking his morning call several times, and finding it without variation, I recorded him:



But one day, at a late hour, when he was at large, I heard him use very different intervals. Listening to the strange version over and over again, I was much surprised and perplexed; for, if I had erred in his case, which was a plain one, what might be my errors in intricate cases! I immediately changed the record to the new form, and wrote in the margin, "Every man is a genius in going wrong." But the next morning my ear caught the first form again. The second was this:

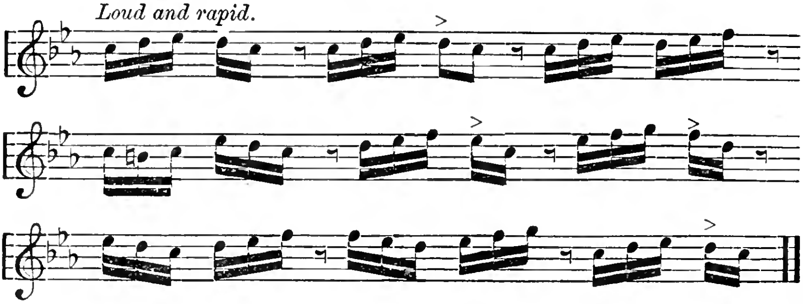
The same to the eye, but very unlike to the ear. Had the second form been given in the key of the first, thus:

it would have seemed more natural; but, as I was correct in both instances, I reasoned that the rooster might be. I finally settled it that the general's first form was his morning indoor salute, and that the second was his out-of-doors "every-day" song; and, furthermore, that he or some of his ancestry had stolen his text from a strain in "The Seven Sleepers," which in my memory runs:

However, a waggish composer offset this theft when he caught the jubilant cackle of a hen as she broke from her nest, heart and throat full of joyous melody—snatched it bodily, I say, clapped it to paper, and made "Old Dan Tucker":

ROSE-BREASTED GROSSBEAK.—I have had several interviews with this bird in different States, but never when prepared to take more than his key-note; so I give his song mostly from memory, feeling confident, however, of the accuracy of the main features and the spirit of it.

The black and white dress of the grossbeak, his breast adorned with a brilliant rose star, instantly attracts the eye, and his loud, ringing song as surely arrests the ear. He sings rapidly and energetically, as if in a hurry to be through and off. No bird sings with more ardor. While on paper his song resembles the robin's, and the key of E flat major and its relative minor are common to both, the voice and delivery are very unlike the robin's:

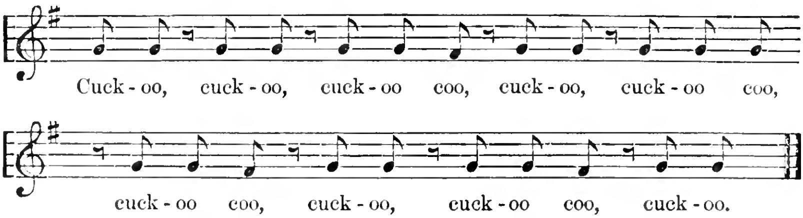


I am told that this bird has also a very musical whistling call.

I found the grossbeaks in Belknap County, N. H., in June, 1886, and in St. Lawrence County, N. Y., in June, 1887.

In their fall migrations they go in flocks, occasionally calling upon the farmers for food, appearing as tame and as much at home as if they had been raised by them. Flocks have passed through northern New Hampshire on their journey south in December, paying leisurely visits to the cider mills for the apple seeds in the cast-off pomace, apparently very little concerned about the cold.

Black-billed Cuckoo.—It is the black-billed cuckoo whose song, with very little merit, has become famous. It must be the low pitch, the solemn manner of delivery, and the quality of tone, that have attracted the attention of the writers; for there is little variety in the rhythm and the least possible in the melody. The rather doleful, straightforward repetition of the singer's name is not heard every day; the cuckoo, too, has his moods.



I have heard this bird nearly every summer of my life, and never any departure from the old, monotonous strain, until recently (1888). Early one June morning, sultry and warm, a bird was exercising his voice in a manner that set me on the alert; it was the voice of a cuckoo, but not the cuckoo's song:

At first thought, it was some bird that had practiced under a cuckoo master. It was an anxious moment, but presently all was settled:

The instant I heard "cuckoo," more especially the second one, giving the interval of a fourth, I experienced a thrill of satisfaction such as no similar discovery had afforded. Other ears, sharper than mine, had heard all, unknown to me, and there was great rejoicing; the cuckoo was learning to sing.

YELLOW-BILLED CUCKOO.—The yellow-billed cuckoo, though he tries hard to make a showing of vocal talent, succeeds only in producing a slovenly, guttural blubbering, with barely tone enough to give positive pitch. The beginning of this effort is a sepulchral and somewhat protracted sound, which bursts into several rapid, boisterous bubbles, followed by others softer and slower, farther and farther apart:

The yellow-breasted chat exhibits the same rhythmic peculiarity in his chattings, and so does the woodpecker, drumming on a board or dry limb for the mere sound of it; but in quality nothing can be compared with this slopping performance, unless it be that of the loose-mouthed hound lapping from a pan of milk.

The cuckoos, graceful, beautiful birds, and ever rapt in solemn reverie, are solitary voices, seldom heard more than one at a time.

OBSERVATIONS carried on for nearly two years at the observatories of Berlin, Potsdam, and Prague indicate the existence of a periodical oscillation in latitude. The maximum occurs in summer, the minimum in winter, and the amount is 0′ 25″. The observations have been conducted with the greatest exactitude, and the results of the three sets are concordant. M. Gaillot has communicated a similar result from observations taken at Paris between 1856 and 1861. The variation may be ascribed to a periodical displacement of the earth's axis, in which case, while the amplitude of the phenomena will be the same at all stations, the times of maxima and minima will vary with the longitude; or it may be an effect due to refraction, in which case the periods will be the same at all the stations.

SKETCH OF NICOLAUS COPERNICUS.

MODERN astronomy may be said to have begun with Copernicus. Previous to his time the received theories of the structure and motions of the universe were incorrect, inconsistent, and incomprehensible, and did not explain the inexact observations that were referred to them. He gave to science a correct theory, in which exact observations have found clear and consistent explanations.

NICOLAUS KOPERNIK was born in Thorn, now in Prussia, but at that time a part of Poland, February 18, 1473, and died May 24, 1543. The accounts vary concerning the station of his family. According to the one which seems best established, his father was a native of Cracow, the son of a man in good position there, and had settled as a wholesale trader in Thorn; his mother, Barbel von Wasselrode, was a sister of a Bishop of Ermeland. His earlier instruction, given him in the school at Thorn, included Greek and Latin letters. He then went, under the patronage of his uncle Lukas, who afterward became bishop, to the University of Cracow, where he applied himself to philosophy and medicine, but more ardently than to either of these branches, under the inspiration of the lessons of Albert Brudzewki, to mathematics and astronomy, in which he made himself familiar with the use of the instruments. He also, in his intervals of leisure, practiced in painting, with considerable success. When twenty-three years of age he proceeded to the University of Bologna, where he attended the lectures of Dominico Maria Novarra in astronomy, and formed a personal friendship with him; and then to Padua, where he studied mathematics and astronomy, and obtained the degree of Doctor of Medicine. In 1499 and 1500 he was in Rome, the associate of the astronomer Regiomontanus, and lecturing on the science to a numerous class. He then returned to his native land, where his reputation for learning and his gentle bearing gained him a cordial welcome. He became a priest, and, under the patronage of his episcopal uncle, a canon of Frauenburg, on the banks of the Vistula. Here, from 1503, he spent the remainder of his life, dividing his time between the duties of his profession, works of charity, and the study of astronomy. He visited the poor and sick, gave them medical attention, and relieved their wants at his own expense; devised a hydraulic system for the distribution of water through the city, remains of which are still to be seen; and composed a treatise on the coinage of money, which was preserved in the archives of the Diet of Grodno. The house which he occupied at Allenstein still stands there, or did very recently, with the holes which he made in the walls of his room in order to observe the passage of the stars across the meridian.

His position here was not, however, one of uninterrupted peace. It fell to him more than once to administer the affairs of the bishopric during a vacancy, and he was charged with the duty of defending the rights and privileges of the see against the Teutonic Knights, who were then very strong. These positions, says M. Biot in the Biographie Universelle, demanded probity and courage. "Copernicus let himself neither be dazzled by the authority of the Knights nor intimidated by their threats. If we repeat these details, which appear foreign to his glory, it is to show that in his character the taste for study and contemplation were united with firmness and constancy—qualities not less necessary than genius for attacking and overthrowing prejudices that had been consecrated by the faith of centuries."

Copernicus lived at the time of the awakening of knowledge, and was a part of it. The idea that the earth moved around the sun was not new; it had been uttered before, but, like many other thoughts that had been expressed among the ancients and then slumbered through the middle ages, it, being contrary to the received notions, was frowned on by authority and was refused a hearing. Copernicus saw, what an intelligent observer could not fail to see, that none of the systems then known could account for the motions of the stars. He had met the most distinguished astronomers of his own time. He was acquainted with all the systems of the ancients; and the more he examined them the more he was astonished at the want of harmony and inconsistency that marked them. "I then took pains," he says, "to read again all the books of philosophy that I could get, to assure myself whether I could find any different opinions from those which were taught in the schools concerning the motions of the spheres of the world. And I saw first in Cicero that Nicetas had expressed the opinion that the earth moves. Then I found in Plutarch that others had had the same idea. . . . Further, the leading Pythagoreans, Archytas of Tarentum, Heraclides of Pontus, Echrecrates, etc., taught the same doctrine, according to which the earth is not motionless in the center of the world, but turns in a circle, and is far from holding the first rank among the heavenly bodies." Pythagoras had learned the same doctrine; Timæus of Locris was very precise in announcing it, when he called the five planets the "organs of time on account of their revolutions," and added that we should have to suppose that the earth was not immovable in the same place, but that it turned around itself and was also carried along in space. Plutarch says that Plato, who had always taught that the sun turned around the earth, changed his opinion toward the end of his life, and regretted that he had not placed the sun at the center of the world, the only place that became it. Three centuries before Christ Aristarchus of Samos, according to Archimedes, composed a work, now lost, defending the doctrine of the movement of the earth against the opinions of philosophers to the contrary, in which he said that "the sun continues immovable and the earth moves around the sun, describing a circular course of which that star occupies the center." Passing to the Romans, this system of Aristarchus was modified into one like that of Tycho Brahe.

In his review of the ancient systems, Copernicus was most drawn, according to M. Biot, "to that of the Egyptians, which made Mercury and Venus revolve round the sun, and put Mars, Jupiter, Saturn, and the sun in motion round the earth; and to that of Apollonius of Perga, which made the sun the common center of all the planetary motions, while the sun itself revolved around the earth—an arrangement that became the system of Tycho Brahe. Copernicus was impressed with these systems because he found that they represented well the limited excursions of Mars and Venus around the sun, explaining their movements, direct, stationary, and retrograde, an advantage which the system of Apollonius extended to the superior planets. The astronomical planets were thus no longer simple sports of the imagination to him. He had studied them experimentally, and had found the conditions which they must satisfy. The hardest part of his discovery was made. On the other hand, he perceived that the Pythagoreans had taken away the earth from the center of the world and put the sun there. It seemed to him that Apollonius's system would be simpler and more symmetrical if it was modified in this sense, so as to suppose the sun fixed in the center, and the earth revolving round it. He had seen also that Nicetas, Heraclides, and other philosophers, while they placed the earth in the center of the world, had ventured to give it a movement of rotation upon itself, producing the phenomena of the rising and setting of the stars and the alternations of day and night. He still more approved the theory of Philolaus, who, taking the earth away from the center of the world, had given it a rotation on its axis and another motion of annual revolution around the sun. And, although it might seem difficult and even absurd to take the earth from the center and make a simple planet of it, yet, as other astronomers before him had taken the liberty of imagining circles in the sky to explain phenomena, he thought he might be permitted to look for some other arrangement, with a moving earth, which would establish a more simple order in the motions of the stars. Thus, taking what is true from each system and rejecting all in them that was false and complicated, he composed that admirable whole which we call the system of Copernicus, and which is really only the correct arrangement of the planetary system to which we belong." "After long researches," Copernicus himself said, "I am convinced that if we refer the motions of the other planets to the revolution of the earth, calculation will agree well with observation. . . . I do not doubt that mathematicians will be of my opinion, if they will take the pains to make themselves acquainted, not superficially but profoundly, with the demonstration which I shall present in this book."

He reasoned that "every displacement manifest to our view proceeds either from the object perceived or from the subject which perceives, or from the unequal motions of the two, for an equal and simultaneous motion of the object and the subject could cause no semblance of displacement. The earth is the place whence the movement of the sky is presented to our view. Every motion starting from the earth is reflected in the sky, which will appear to move in the opposite direction. Such is the diurnal revolution, which appears to involve the whole universe except the earth. If now we suppose that the sky has none of this motion, but that the earth turns around itself from west to east (in a contrary direction from the apparent motion of the sky), we shall find that it is really so." Among the chief arguments in support of this view, the astronomer insisted especially on the immensity of the sky as compared with the size of the earth. "The whole mass of the earth," he said, "vanishes before the grandeur of the sky; the horizon divides the celestial sphere into halves, which could not be if the earth bore any proportion to the extent of the sky, or if its distance from the center of the universe was perceptible. Compared to the sky, the earth is only a point; it is as a finite quantity compared with an infinite quantity. It is no more admissible to suppose the earth resting in the center of the universe. What! to believe that immensity turns every twenty-four hours around an insignificancy!" So the inequalities in the movements of the planets—their forward and backward movements and stationary positions—were referred to two causes: the movement of translation of the earth and the proper motions of the planets; correctly, as modern astronomers explain them, only Copernicus was not able to give details and exact figures.

Ptolemy had argued against the idea of these motions of the earth, because if the earth were translated through space it would leave all the loose things on it behind; and, if it turned on its axis from west to east, it would be impossible for bodies to make any headway to the eastward, for, whatever the rate of their motion, the earth would always reach a given point in that direction first. Hence the former idea was the most ridiculous of all (*πάντων γελοιότατα*), and the latter altogether ridiculous (*πάνυ γελοιότατον*). These arguments seemed unanswerable, and had been received, with Ptolemy's theory, till they had become almost an article of faith. It required a courage which we can only weakly comprehend at this day for a student to fly in the face of the world, of science and religion, and take the solar system to pieces, to put it together again, and to say, after all, that it is the earth which moves and not the sun. Copernicus was slow in venturing before the public with his theory. He began the formulation of his system in 1507; but he wisely determined to make thorough work of the matter, and publish nothing that he could not support with carefully considered argument and evidence. He would not be satisfied with reconciling general appearances with his theory; he would go into details and show how it fitted individual phenomena. He would show how all the movements of the heavenly bodies could be accounted for and predicted by it; even how those phenomena which had hitherto proved unaccountable, the stationary positions and retrograde motions of the planets, and the precession of the equinoxes, found explanation in it. In the mean time reports had got into circulation respecting his new theory, and the public wanted to know what it was. Astronomers were waiting for it, and he was urged to publish it. But he delayed, revising his sheets daily for the insertion of corrected data, and adding new results; and he shrank from the inevitable conflict with the prejudices of the day. These prejudices were already beginning to make their mark. Men of science could accept his views or give them utterance, so far as they had been made acquainted with them, but the general public was against them. He was ridiculed in a comedy; but his gravity and self-restraint carried him safely through all these trials. At last he permitted his friends to publish the work, which he dedicated, in deprecation of clerical censure, to Pope Paul III, in order, as he said in the dedication, that no one should accuse him of running away from the judgment of enlightened men, and that the authority of his Holiness, if he should approve the work, might secure him against the stings of calumny. "I believe," he also said, "that as soon as what I have written in this book concerning the motions of the earth is known, a cry of shame will be raised against me. I am, further, not so much in love with my ideas as to be careless of what others might think about them. And, although the thoughts of the philosopher differ from the aims of the crowd, because he proposes to seek for the truth, so far as God has given it to human wisdom to do, I am not yet ready to reject entirely opinions which seem to be at variance with mine. . . . All these motives, together with the fear of becoming—on account of novelty and apparent absurdity—an object of ridicule, had nearly caused me to renounce the enterprise. But some friends—among them Cardinal Schomberg and Tidium Gisius, Bishop of Kulm—succeeded in overcoming my repugnance. The last, especially, insisted most earnestly on my publishing this book, which I had kept on the shelf, not nine years, but nearly thirty-six."

The book (*De Revolutionibus Orbium Cœlestium*) was printed at Nuremberg, under the care of Rheticus, one of Copernicus's pupils, in 1543. Although Copernicus had till that time been enjoying excellent health, he had then been attacked by a dysentery; and this had passed into a paralysis, with loss of his mental faculties, when the first copy of the book was given to him only a few hours before his death. He saw it and handled it, but was too far gone to exhibit any signs of appreciation of it, or for his friends to be able to know how he was affected by it, or whether he realized what it was. The first edition of the *De Revolutionibus*, which is now very rare, was followed by a second edition in 1566, and a third in 1617. Seventy-three years after the death of its author, on the 5th of March, 1616, it was condemned by the Congregation of the Index "for containing ideas set forth as true on the positions and motions of the earth entirely contrary to the Holy Scripture."

The first work recording the labors of the astronomer was the letter published by Rheticus under the title *Ad Clar. V. de Jo. Schonerum de Libris Revolutionum eruditiss, Viri et Mathematici excellentiss. Rev. Doctoris Nicolai Copernici Torunnæi, Canonici Varmiensis, per quemdam juvenem Mathematicæ studiosum, Narratio prima*, Dantzic, 1540; reprinted, with a eulogium, at Basle, 1541. The works of Copernicus are *De Revolutionibus Orbium Cœlestium Libri VI*, Nuremberg, 1543; reprinted at Basle in 1566, with the letter of Rheticus, and also included in the *Astronomia Instaurata* of Nicolas Muller, Amsterdam, 1617 and 1640; a treatise on Trigonometry, with tables of sines, entitled *De Lateribus et Angulis Triangulorum*, Wittenberg; *Theophylacti Scholastici Simocattæ Epistolæ morales, rurales, et amatoriæ, cum Versione Latina.* There are also the treatise on money, already mentioned, and several manuscript treatises in the library of the bishopric of Wiarmia.

The tomb of Copernicus, which was exactly like those of the other canons of Frauenburg, was adorned with a Latin epitaph by the Polish Bishop Cromer, in 1581. It was repaired by Napoleon I in 1807, and so placed that it could be seen from all parts of the church. A statue of Copernicus by Thorwaldsen was erected by subscriptions from the Polish people, in 1829, in the Casimir Palace at Warsaw. The Polish clergy, invited to attend the ceremonies, refused, because his book had been condemned by the Holy Office in 1616. Another monument to him, by Tieck, was erected at Thorn in 1853.

CORRESPONDENCE.

FEET-WASHING AND FEET-KISSING.

IN his article on Greeting by Gesture, in The Popular Science Monthly for February, Colonel Garrick Mallery gave some three pages to the usages in respect to kissing, and said among other things, "Some religious sects—e. g., the Dunkers—also kiss one another's feet—after washing them."

The following note has been sent us respecting this statement.

Editor Popular Science Monthly:

MY DEAR SIR: In the Chicago Tribune of January 31st, I notice an article from your periodical, entitled Kissing has a History. In it occurs the following: "Dunkers also kiss one another's feet when they have washed them." Your historian lacks information, both on the teachings of the Bible and the practice of the Tunker Church, which follows strictly the instructions of the former. I have been a member of the Tunker Church over thirty-five years, and have many times taken part in the Bible command, "Wash one another's feet" (John, xiii, 14), and the injunction, "Salute one another with a holy kiss"; but I never saw them "kiss one another's feet," as your historian states. I send you herewith a proof of an article found in our own Church Almanac for 1891. It will give you and your people some idea of our people. I shall be pleased to make a correction if you feel so disposed. Hoping that I may not be misunderstood, I remain,

Yours truly,

J. G. ROGER,
Professor of Mental and Moral Science,
Mount Morris College.

The article mentioned in the note is an account of the history, doctrine, and usages of the Brethren or Dunkers, compiled by Mr. D. L. Miller. It says, concerning the particular point to which attention is turned:

"The love-feast, which they believe to be patterned after the Supper of the Lord, is a full meal, prepared and placed upon the table used for that purpose in the church, and is partaken by all the members to the satisfying of hunger. It is preceded by the religious rite of washing feet—a service emblematical, as originally described in John, xiii, of the equality of all the members in service, and "bears no more relation to personal cleanliness than the act of baptism does to a bath . . . In its practice, at the love-feast occasions, water is poured into a basin, and a towel or apron is girded about the brother, and, from the example given by Christ, he typically washes his brother's bared feet, as an evidence that he is his servant, and the other his master. The relations are then reversed, and the servant then becomes the master. . . . The sisters wash the sisters' feet, and all the proprieties of the sexes are most rigidly observed. After observing the ceremony of feet-washing, a blessing is asked upon the simple meal spread on the tables, and it is eaten with solemnity. . . . At the conclusion of the meal thanks are returned, and then, as the members are seated around the tables, the right hand of fellowship and the kiss of charity are given. The salutation of the kiss of love in worship and in customary greetings, as enjoined by the apostle, is never observed between the sexes."

The administration of the communion follows.

Colonel Mallery, to whom we sent Prof. Roger's letter and inclosure, explains that his reference to the Dunkers was a merely incidental illustration of the principles he was setting forth in his article. It is a matter of his recollection, his early life having been passed in Philadelphia, now including Germantown—places which are mentioned in Mr. Miller's paper as the earliest American seats of the Dunkers. He distinctly remembers having heard the practice spoken of more than forty years ago by persons who witnessed the ceremony.

"Though our correspondent," he says, "has not heard of kissing the feet in connection with their ceremonial washing among the Dunkers during the thirty-five years in which he has been connected with them, that does not prove that the kissing part of the ceremony was not practiced forty years ago, and that it has not continued later in parts of the country with which he has not been familiar. The Dunkers, popularly known also by other titles, have probably not long enjoined a ritual so immutable and distinct that it could not be varied at their scattered seats by the influence of tradition or individual taste. We have been informed by a frequent visitor to Germantown, Pa., before 1847, that foot-kissing was then and there commonly reported to be practiced among the Dunkers; we are also furnished with the statement of a resident of Allentown, Pa., that he witnessed that performance by them.

"It would be strange if foot-kissing as a further exhibition of brotherly love had not survived with the foot-washing into this century, through such regions as Pennsylvania, to which the Dunkers had very early brought the Old World rites. Anciently in the Roman Catholic Church, when foot-washing was regularly performed on Maunday or Holy Thursday, the officiating priest kissed the feet that he had washed. Though in the Catholic countries where foot-washing is still observed, their kissing has perhaps generally ceased, it continued even among English Protestants until the time of Queen Elizabeth. An elaborate account of it in 1572 appears in Brand's Popular Antiquities, vol. i, p. 145 *et seq.* (Bohn's edition), in which the kissing of the feet is twice mentioned. It is also specified in Cavendish's Life of Wolsey as practiced by the cardinal in 1530."

After preparing the above statement, Colonel Mallery received two further accounts of kissing in connection with feet-washing among the Dunkers; one was from Philadelphia by an eye-witness, who thoroughly bears out his own statement and recollection. He has also been told by a gentleman from St. Louis, who called upon him, that on the last Holy Thursday, March 26th, the kissing of feet in connection with the foot-washing ceremony was performed there by the Roman Catholic archbishop, and that there were full accounts of that kissing in the papers of the next day. It is really curious, Colonel Mallery adds—and more is in the matter than he at first thought—that in parts of the United States the ceremony goes on in 1891 as a histrionic presentment of traditions generally abandoned.

EDITOR'S TABLE.

LIBERTY AND CIVILIZATION.

IF argument can avail aught in the practical direction of events, the volume lately published under the title of A Plea for Liberty ought to exert a powerful influence upon the politics of our day in so far as they are occupied with questions of social reform. The book is packed with well-digested information and solid reasoning, and no one can fail to derive from its perusal a clearer and wider comprehension of the social problem in its various aspects. The great question which continually presents itself, whatever department of social work we turn to, is, Shall we attempt to hasten improvement by legislation, or shall we trust to the resources of freely acting individuals to modify things in their own interest and to their own advantage? Sometimes, no doubt, legislation, national or municipal, is our only recourse; but the teaching of the book before us is that this recourse has been had in a multitude of cases in which the problem would have been far better solved by individual initiative and action. Another point which is well brought out is that philanthropy in the great majority of cases misses its aim; it wishes to do good, and it does mischief, just reversing the procedure of that ancient prophet who tried to curse, but found himself blessing against his will.

The general issue before the world at the present moment is a very serious one. Mr. Spencer has well expressed it when he entitles his introductory essay From Freedom to Bondage. There is an undoubted danger lest, as he says, those structures in the body politic which make for regulation should gain such a development and such a preponderance as to leave but an insignificant measure of freedom to the social units, and thus, by cramping their activities, fatally impair their energies. We know what a torpor has crept over the Eastern nations through the stereotyping of customs and institutions multiplied beyond all reason. Some one will perhaps say: "Shall we not always remain a free people, with power to change our institutions if they become burdensome? And what does it matter who does social work so long as it is done?" Both questions deserve answer. An institution may be burdensome and hurtful without being felt to be so; or, if felt to be so, the feeling may not be sufficiently acute to prompt to the action necessary to obtain a change; or, again, the feeling, though more or less acute, may not be accompanied by a sense of power to make the change. Look at individuals. Does every individual who theoretically possesses the power to alter his mode of life to his own advantage put that power into exercise? Does every individual who is shown a more excellent way at once shake off ancient habit and enter on the better path? We all know the enormous influence which procrastination, inertness, love of ease, and prejudice in favor of what is established exert on individual lives; and even so is it with society. There is salvation for the individual at given moments, at special conjunctions, at certain partings of the ways; but, the favorable opportunity missed, the situation becomes more difficult and hopeless with every hour. In social matters the civilized world has been going wrong for years past, and is now threatened with a vast increase of the tyrannical legislation which it has been inviting. It may not be too late yet, however, to make a stand, and perhaps to reverse the current of change. The object ot A Plea for Liberty is to force reflection on the subject, and, if possible, to dispel the illusion under which so many have fallen that legislation alone, the action of the state, can make a way for us out of our social difficulties.

Mr. Spencer lays stress on the fact that, in many departments of life, without the intervention of government, progress is being made every day toward a better state of things. There is a power of self-adjustment in individuals which, if not artificially checked, makes infallibly toward better conditions. Elsewhere in the volume we are shown the drawbacks that more or less attend all corporate action, but which in a very marked manner attend the action of the most comprehensive and potent corporation of all—the state; and thus are furnished with an answer to the second question, which a few moments ago we were supposing to be asked: What does it matter who discharges any particular function, so long as it is discharged? If it can be shown that, within the whole radius of state-directed activity, there is a diminution of the motives that give to labor and effort their highest efficiency, then it matters a great deal whether individuals are acting freely as individuals in full contact with a natural environment or whether they are replaced by a host of state-paid employés, dragging on in a lazy and intermittent fashion a lumbering governmental machine. Nothing is more capable of demonstration than that government work is, in general, done in a more or less inefficient and perfunctory manner, and always in a wasteful manner. The natural conclusion to draw from this fact would be that the functions of government should be curtailed as much as possible, so that we might have as little as possible of such inferior and expensive work. Unfortunately, this conclusion is drawn by but few. The results of government work are visible and tangible. They are manifest in buildings, harbors, vessels, blue-books, and people are imposed upon by the scale of the operations of the state. They do not ask how much greater or better results the money expended might have yielded; still less do they ask how much of private enterprise has been paralyzed by an unnecessary extension of the functions of the state. But these questions should be asked, and it is the merest unthrift not to ask them. Of all the printing done by the Government in this country, for example, how much serves a really useful purpose? How much finds its way to the junkshop, and thence to the paper-mill? If accurate answers could be had to these questions, we think that even an indifferent public might be aroused.

One of the best essays in the volume

we are discussing is that contributed by the editor, Mr. Thomas Mackay, on Investment. In a certain sense it may be said to cover the whole ground; for it deals in the most exhaustive and logical manner with the pretension put forward by socialists that all capital should be vested in the state and used by it for the general good. It shows that as an investor of capital the state is conspicuously incompetent, and that this is so from the very nature of the case. We are tempted to reproduce Mr. Mackay's terse and vigorous statement of his own position: "We argue that capital should belong to him who has earned it, that he alone can make the best use of it, and that he alone should suffer if it is allowed to disappear in ill-considered ventures, or to waste away more rapidly than is necessary for want of due reparation and care; further, that the right of bequest and inheritance is the most economical as well as the most equitable method for the devolution of property from one generation to another; and that the socialist ideal of the universal usefulness of capital, which is our ideal also, can be reached by an ever-widening extension of private ownership and by that means only." This is a succinct and to us refreshing statement of the individualist position; but Mr. Mackay is careful to add that he has no "superstitious respect for the laws which guarantee to owners too extended an authority over their property"; and he lays down what seems to us a useful definition when he says that "the rights of property are those which the mutual forbearance of the members of society finds convenient and indispensable." He thinks that matters in which the courts of law now intervene could be better settled by the parties out of court, and that a certain curtailment in the number of actionable cases might well be made. "In an atmosphere of liberty human character," he declares, "has an adaptability which will prove equal to all occasions." What he desiderates is a "character saturated with the motives of the free life, and in the conviction realized by experience, sanctioned by free choice and made instinctive by custom, that the free interchange of mutual service and mutual forbearance is the beneficent and yet attainable principle on which the well-being of society depends." These, however, are mere expressions of opinion, and Mr. Mackay does not put them forward without bringing facts to their support. His criticism of the state as an investor of the people's money will be found most searching; at the same time he frankly admits that the constantly recurring scandals which mark national and municipal administration are due, "not so much to the incapacity of vestrydom as to the impossible duties for which it is held responsible." He believes (with Henry George) that the legal restrictions on the liquor-traffic have impeded the growth of temperance, and he gives his reasons which we can not here reproduce. Of capital philanthropically employed, he says very tersely that "its usefulness varies inversely as its philanthropy"; and this opinion, too, is backed by cogent reasons drawn from actual experience. Long ago the world's greatest dramatist said, in a passage which Mr. Spencer has most effectively quoted in his First Principles,

> "Nature is made better by no mean,
> But Nature makes that mean."

We may apply this somewhat differently from what Mr. Spencer has done, and say that Nature can not be bettered by any mean that is not itself *natural;* and it is because so much philanthropy is against Nature—actually intended to check and antagonize the working of natural laws—that it so signally and lamentably fails of any useful effect, and tends rather to aggravate social evils. The laws of the universe are more beneficent than we sometimes take them to be, even the law of natural selection which is so often railed against as cruel.

We sincerely hope that the gospel of liberty, preached by Mill in his celebrated essay, and now preached anew, with a vastly enlarged array of proofs in the book to which we have called attention, will gain the ear of the world and rescue its civilization.

LITERARY NOTICES.

The Autobiography of the Earth. By Rev. H. N. Hutchinson, F. G. S. New York: D. Appleton & Co. Pp. 290. Price, $1.50.

Those who know but little of the science that deals with rock-formations, and regard it as one of many perplexing 'ologies, would be surprised to see what a fascinating story the earth's geological record becomes, as told in this book. The author has not written a text-book, but a volume designed to give the general reader an understanding of the process that has molded the superficial layers of the earth's crust into the forms they bear to-day. In his preface he says: "Many a sportsman or pedestrian, we believe, pauses now and again to examine some curious stone which attracts his attention, or looks at the rock or bowlder on which he rests for a mid-day repast, and would like to understand a little of its previous history. But, not knowing where to turn for assistance, he remains ignorant of a subject of which even a slight knowledge would greatly add to the pleasure of his rambles over the country." The author states that the plan of his book is, "First, to give in simple language, and in a style which it is hoped will not deter the reader, a brief sketch of the former history of our planet, beginning with its first appearance as a member of the solar system, and passing through all the different geological periods, with their changing scenes and various phases of life, down to the latest period, when man appeared on the scene. Secondly, to explain, however briefly, the methods by which the conclusions of geologists have been arrived at, or, in other words, to put the evidence before the reader so that he may see how those conclusions were formed, and judge for himself how far they are reasonable. To do this at all fully in a small book was of course impossible, but it was thought better to attempt brief explanations than to state conclusions which, without reasons, might seem very arbitrary. Such as are given may in some cases be inadequate or incomplete, but at least they will serve to give the reader an insight into the methods of geology, and may possibly lead some to further study, and especially to personal observation. Geology can not be learned from books alone. Observation and a little reflection will help the student far more than reading. Study should be combined with field work, and in this way only can the subject be mastered." It is now fully recognized that the culture demanded by modern life includes an acquaintance with the chief fields of science. This book introduces the reader into one of these fields in a notably happy manner.

A Move for Better Roads. Essays on Road-making and Maintenance and Road Laws. Philadelphia: H. C. Baird & Co. Pp. 319. Price, $2.

Important work in the cause of road-improvement has been done in the preparation and publishing of this volume. The essays which it contains were written in competition for prizes of four hundred, two hundred, and one hundred dollars, offered by William H. Rhawn and other citizens of Philadelphia, and awarded by a board of adjudicators appointed by Dr. William Pepper, Provost of the University of Pennsylvania. The paper for which the first prize was given was written by Henry Irwin, B. A., C. E., of Montreal, assistant engineer on the Canadian Pacific Railway. As required by the conditions of competition, this essay takes up the engineering, the economic, and the legislative features of road-making. The writer gives hints as to locating roads, states what grades are allowable, what widths are required in various cases, and discusses all the other details of construction. One thing on which he lays much stress is drainage. "It is almost impossible," he says, "to make a good road on a wet, yielding soil, except by going to great expense in providing a heavy concrete foundation. . . . In northern latitudes the remark is frequently made in the spring that 'the frost has heaved the road.'" Mr. Irwin says that "the proper remark to make in such a case would be, 'The road is badly drained,'" and he recommends that all roads should have a ditch about four feet deep on each side, outside the fences. In particularly wet places the road-bed should be thoroughly subdrained. For use in cities he names asphalt, stone blocks, wooden blocks, and brick as suitable pavements, giving the advantages and disadvantages of each. He states that a concrete foundation, which need not be very rich in cement, should be provided for any of these. For country roads Mr. Irwin is convinced that the Telford-Macadam system is by far the best, and he says that it is not much more costly than a sufficiently deep simple Macadam. He then goes on to tell what stone should be chosen for the road-metal, how it should be broken and laid on, and how the surface of the road should be finished. While urging the general use of macadamized roads, he does not omit to tell how gravel and earth roads can be improved. Under the head of maintenance Mr. Irwin touches on cleaning and repairing the surface of roads, and cleaning out drains. Under economic features, he gives figures that show how much loss farmers suffer from bad roads. "A farmer who might send produce into market for two hundred days in the year, using a pair of horses to draw a load of about a ton on a poor gravel road, could, if the road were well macadamized, dispense with one of the horses. Supposing that the horse cost him forty cents per day (including interest on first cost), he would save on this single item eighty dollars per annum." Then there is the wear and tear of wagons and harnesses to be considered, and the loss in the price of produce from not being able to get it into town when it is wanted, or not fast enough, if the roads happen to be deep in mud at that time. From the Engineering News of February 22, 1890, is quoted a "statement made by Captain Brown, manager of Hollywood truck-farm in Virginia, to the effect that a pair of horses can draw fifty-five barrels of produce over the roads on that farm, which are in excellent condition, whereas on the ordinary country roads they can only draw twelve barrels." As to road legislation, Mr. Irwin recommends that control over all public roads and bridges should be given to a council in each county. The council should appoint an engineer, assistants, and clerks, whose tenure of office should be permanent. He also recommends the employment of convicts in cleaning and repairing county roads, or in breaking stone at the jails.

The writer of the second-prize paper, David H. Bergey, B. Sc., M. D., devotes considerable space to general discussion of the subject. His recommendations and statements agree generally with those of Mr. Irwin, though he prefers the Macadam to the Telford road. The third-prize essay, by James B. Olcott, of South Manchester, Conn., is quite similar to the preceding. One thing that he protests against is the putting of a layer of broken stone, by contractors, over the surface of a road for the public to wear it down by the wheels of their vehicles. Five papers that had received honorable mention are also published. The writers of these, without reference to order, are Edwin Satterthwait, President of the Cheltenham and Willow Grove Turnpike, Jenkintown, Pa.; Charles Punchard, of Philadelphia; George B. Fleece, C. E., Memphis, Tenn.; Frank Cawley, B. S., Instructor in Civil Engineering, Swarthmore College; and Francis F. McKenzie, C. E., of Philadelphia. A digest of the main suggestions in the other papers that were submitted, and a review of all the essays by Prof. Lewis M. Haupt, the secretary of the committee that arranged the competition, follow the above. A list of brief rules, published by the Road Improvement Association, of London, is appended. The committee intends to publish also a draft or drafts of a model legislative bill for a road law.

This subject is one which profoundly affects the interests of farmers, and will return ten times as much for money, time, and effort expended on it as the ordinary political schemes which promise to do so much for the farmer in return for his support. The above-described volume should have a wide circulation, and should find a place in every public and school library in our farming communities.

Studies in Psychology. By S. G. Burney. Nashville, Tenn: Cumberland Presbyterian Publishing House. Pp. 535.

The author of this work is Professor of Systematic Theology in Cumberland University, and is author of a book on moral science and some works in theology. The volume contains the substance of his class-lectures, which were prepared for that particular purpose, and are published only at the solicitation of successive classes of students. The treatise is original in the sense that it embodies the author's own independent thoughts, with free criticisms of the writers of the esoteric school who have preceded him, and from whom he differs widely on several important points. It usually, however, has those in view, and, however freely his own theories may be presented, those of the others are not far away. Among the more important points of difference from other standard works are the endeavor to avoid the perplexity arising from the practice of formally accepting any given analysis of the mind, and then practically disregarding it in attributing to one faculty the functions of another; it rejects the doctrine of complex faculties, complex feelings, and complex action, and opposes to it the principle that these features are all simple, though interdependent; it also rejects the doctrines that consciousness is cognitive; that there are a voluntary consciousness, a latent consciousness, and unconscious influences exercised over the mind by unknown objects; that there is an involuntary attention, and the mind can attend strictly to a multitude of objects at the same time; and of the objectivity of time, space, beauty, and sublimity in the form in which those phenomena are generally stated. It differs from the more common theories concerning identity, memory, and the laws of association or mental suggestion. The doctrine of sensibility is discussed briefly; and the text-book presentation of the will is supplemented by a review of the prominent teachings concerning it of a number of the more popular authors from Augustine to the present time. The study offered in this book is wholly from the interior, the author holding, with all who have treated of the subject prior to the rise of the evolutionist school, that "in mental science the mind deals exclusively with itself, or rather studies itself through the facts given in consciousness." We are not disposed to belittle the value of the esoteric study. It has been well attended to by the authors of the past, to whom Prof. Burney often refers, and whom he often also criticises; but the publications of Spencer, Maudsley, Sully, and Ribot have shown that the study from the outside is even more valuable, and has already furnished a large volume of data essential to a full knowledge of the subject, and competent to answer some of the questions which the esoteric theories still leave open. While the adherents of this school may not accept all the conclusions of the evolutionists, they will find that they can not be ignored, and that no treatise can in this day be considered complete that does not take account of them.

A Short Course of Experiments in Physical Measurements. By Harold Whiting. Part II. Cambridge: John Wilson & Son. Pp. 305.

The present portion of this work, the first part of which has been noticed in the Monthly, is devoted to sound, dynamics, magnetism, and electricity. The measurements relating to sound are merely the conclusion of the subject. Under dynamics are included experiments on the pendulum, the measurement of force, elasticity, and cohesion, and the determination of work done. The measurement of the distance between the poles of a magnet, the deflections of compass needles, and magnetic dip are among the experiments under magnetism. Several methods of measuring electrical currents, electrical resistance, and electro-motive force are given. In the concluding pages there are a few experiments for advanced students in various departments of physics, and the use of certain instruments of precision is described. The volume is illustrated with many diagrams and cuts of apparatus.

Principles of Social Economics. By George Gunton. New York: G. P. Putnam's Sons. Pp. 447. Price, $1.75.

The author divides this treatise into four parts, dealing respectively with the principles of social progress, of economic production, of economic distribution, and of practical statesmanship. He defines social progress as "the movement of society toward the realization of the highest material, intellectual, and moral possibilities in human life," and states that it "consists in a series of changes from a relatively simple to a relatively complex state of social organization." Its cause is "man's conscious effort to adapt social institutions to his own needs and desires." Considerable historical matter is cited in support of these views. In Part II, on production, Mr. Gunton criticises various definitions of wealth previously given, and thus defines it himself: "Everything may be regarded as wealth, the utility of which is actualized by human effort." Other topics discussed in this section of the book are the nature of value, relation of demand and supply, prices, cost of production, and the function of money. The author advocates the issuing of money by private enterprise, under government supervision. In the part on economic distribution he discusses various theories in regard to wages, rent, interest, profit, etc. Mr. Gunton regards the *laissez-faire* doctrine as unscientific, claiming that it is not likely to secure the survival of the most fit. In regard to international trade he affirms that protection should offset difference in wages, but should do no more; he argues the superiority of a home market over a foreign, and maintains that "no competition can promote industrial well-being which does not tend to make wealth cheap." The sub-title of the book—"with criticisms on current theories"—is amply justified, for nearly every prominent economist is criticised, from Adam Smith to Blaine.

The Missouri Botanical Garden. First Annual Report, 1890. St. Louis. Pp. 165.

This volume embodies a record of the founding of the Missouri Botanical Garden and of the Henry Shaw School of Botany. It contains a biographical sketch of Henry Shaw, from which it appears that the idea of laying out a garden first came to him during a visit to England, his native country, in 1851. Preparation of the ground for the garden was begun in 1857. In the same year the assistance of the late Dr. Engelmann, then in Europe, was secured to gather suggestions from foreign botanical gardens, and at about the same time a correspondence was begun with Sir William J. Hooker, whose advice largely influenced the shaping of the institution. Mr. Shaw had retired from business, and during the rest of his life—over thirty years—the development and supervision of this garden was his sole care. An outgrowth of the garden was Tower Grove Park, containing two hundred and seventy-six acres, in which more than twenty thousand trees have been planted, all raised in the arboretum of the garden. This volume contains also Henry Shaw's will conveying the garden to a board of trustees, and providing for its maintenance, and also devising property to Washington University for the establishment of a School of Botany. The will is followed by the inaugural exercises of this school, held on November 6, 1885, a report on the school, made in June, 1890, and the first annual report of the Director of the Botanical Garden, covering the year 1889. The inaugural exercises include an address by William Trelease, Engelmann Professor in the school. There is also the first of a series of annual "flower sermons," and the proceedings at the first annual banquet of the trustees of the garden and their guests, funds for both of which commemorations were provided by the will. The volume is illustrated with many full-page views of buildings and spots in the garden and park, maps of the grounds, and a portrait of Mr. Shaw.

Building-Stone in New York. By John C. Smock. Bulletin of the New York State Museum. Vol. II, No. 10. Albany: University of the State of New York. Pp. 203.

A large amount of information is contained in this report, embracing the geological position and the composition of the building-stones found in the State of New York, the localities where they are quarried, the extent and nature of their use, their durability, etc. The descriptive notes in regard to quarries are arranged under the two general heads crystalline rocks and fragmental rocks; the former including granites, limestones, and marbles, and the latter comprising slate and a variety of sandstones. Under each kind of rock, each locality where it is quarried receives a paragraph. There is an important chapter on the use of stone in cities, in which is stated the general purposes for which the several kinds of stone are used in each of the cities of the State, names of structures built of each kind being given. Many of the stones here mentioned come from without the State. A report on physical and chemical tests of representative building-stones of New York, by Prof. Francis A. Wilber, is inserted, and there is a chapter on the durability of stone and the causes of its decay. One reason given for the rapid decay of sandstone in recent years is, that lately much of the stone has been set on edge. A folded map of the State on which the towns where there are quarries are marked accompanies the volume.

Church and State. By Count Leo Tolstoï. Boston: Benjamin R. Tucker. Pp. 169.

This collection of essays, better than any other, shows in strong light the peculiar logic of the Russian novelist. The subjects discussed are Church and State; Money; Man and Woman, and the Mother.

A remarkable dissertation on the origin and use of money takes up the greater part of the book, and is worth reading only as an abnormal subject is valuable for dissection. At the outset it is unequivocally declared that *money* is the cause of slavery, but this proposition is so obscured in the conclusion that many paragraphs are devoted to proving that slavery results from the compulsion of the unarmed by the armed! These are some of his inimitable ideas: "To say to-day that money does not produce slavery is as correct as it was correct fifty years since to say that serfdom did not produce slavery. . . . To plain people it appears beyond doubt that the immediate cause of the enslavement of some men by others is money. But science, denying this, says that money is only a medium of exchange, which has no connection with the enslavement of men. . . . Doubtless money has those harmless properties which science enumerates; but it has them in reality only . . . in an ideal society, but in such a society money would not exist at all; . . . its main function is not the serving as a medium of exchange, but the serving as a means of compulsion." The proof of this assertion Tolstoï proceeds to find in the history of the Fiji Islands. The Fijians were unacquainted with any means of exchange other than barter until American colonists came among them. Some of the American intruders were injured by Fijians, and the United States Government demanded forty-five thousand dollars indemnity for the outrages. The Fijians appealed to England for protection, borrowed money, and finally became enslaved—*ergo*, money is the cause of slavery!

The scientific method of investigation is somewhat slower than this electric Russian would have it, so he compares it to "a lazy, restive horse," and states at length: "Science has a definite purpose, which it accomplishes. The purpose is, to maintain the superstitions and delusions of the people, and thereby *hinder humanity in its advance toward truth and welfare.*" It is hardly worth while to pursue such folly much further, yet Tolstoï carries this agility of conclusion into his examination of all social questions. In another essay he enunciates the following theorem: 'The service of mankind resolves itself into two parts: 1. The improvement of living men and women. 2. The perpetuation of mankind itself. To the former men are chiefly called, *since the possibility of the latter service is denied them.* To the second women are called, as they are exclusively capacitated therefor." At one time he would make the world a vast nursery where the ideal woman rears the greatest possible number of children; at another he declares, "The continuation of the human race will no longer be necessary for those who are living a true life."

The celebrity of this author makes any utterance from him noticeable; but, however highly his imaginative power may rank him as a novelist, there is no continuity or sequence to his arguments, and as a thinker he is wholly out of joint.

Household Hygiene. By Mary Taylor Bissell, M. D. Fact and Theory Papers, No. 7. New York: N. D. C. Hodges. Pp. 83. Price, 75 cents.

We rarely see a book that hits its aim so pat as this one does. It covers an important subject with a serviceable degree of completeness, it contains nothing that is superfluous or unavailable to those for whom it is written, and it is everywhere clear, forcible, and direct. The author's statement of what she has attempted is no less apt than the body of the book. "This little volume," she says, "has been compiled with the hope that the housekeeper of to-day may find in its pages a few definite and simple suggestions regarding sanitary house-building and housekeeping which will aid her to maintain in her own domain that high degree of intelligent hygiene in whose enforcement lies the physical promise of family life."

Nothing more is needed by way of description but to give the chapter headings; these are: The Site and the Soil; Hygiene in Architecture; The City House and Plumbing; The Country House; Ventilation and Heating; Our Water-supply; Kitchen and Table Hygiene; Sanitary Furniture; The Sick-room; Roof Gardens.

Open Sesame! Poetry and Prose for School-days. By Blanche Wilder Bellamy and Maud Wilder Goodwin. Vol. III. Boston: Ginn & Co. Pp. 861.

This volume, the closing one of the series, is intended for pupils over fourteen years of age, and young students in search of something to read or recite can scarcely fail to be satisfied with its varied contents.

There are rhymes of old-fashioned flavor from Chaucer and Robert Herrick and verses of modern seasoning by Joaquin Miller and Walt Whitman. The shorter masterpieces of English are given, as well as poems culled from Omar Khayyam, Schiller, and Victor Hugo. Famous stirring addresses are chosen from the time of Thucydides and onward, and wise words of counsel from Prof. Huxley and Jane Welch Carlyle.

The selections are grouped under five headings—Sentiment and Story; Art and Nature; Loyalty and Heroism; Song and Laughter; Holidays and Holy Days—and to each section an illustration is prefixed.

The State University of Iowa publishes semi-annually a journal entitled *The Transit*, edited by the Engineering Society in that institution (price, 50 cents). The second issue was that for December, 1890, and is largely devoted to the details of a series of cement tests carried on in the department of engineering. The paper was prepared by Mr. Hubert Remley, one of the authors of the article on cements in the Monthly for March, and is illustrated with diagrams and cuts of apparatus. Besides this, there are two short papers on cements in this issue, and other papers on The Preservation of Timber, A Simple Method of determining Latitude, and on Paving-Brick and Brick Pavements. Two of the university buildings are described, with illustrations, and the issue contains also editorial matter and a list of courses in engineering given by the university.

Two addresses by Prof. *Delos Fall* have been reprinted together from the Report of the Michigan State Board of Health for 1890. One, on *School Hygiene*, urges attention to everything that affects the health of children during school hours. The other is *A Study of the Action of Alcohol on the Human Body*, and presents, without any fanatical ranting, the evils which physiologists say that alcohol inflicts upon the human body. It also quotes General Greely as stating that the regular taking of alcohol is useless, or worse, in very cold regions, and Mr. Stanley as having the same opinion of its use in very hot regions.

Some of the experimental psychological studies of *Alfred Binet* have been published in a pamphlet entitled *On Double Consciousness* (Open Court, 50 cents). An essay on Experimental Psychology in France is prefixed to these studies, in which the special fields are mentioned that the leading psychologists of that country are engaged in, most of these being embraced in the domain of pathological psychology. By double consciousness is meant the capability of hysterical persons to respond to excitations of an insensible part of the body without being aware that the excitation or response has been made. The author describes experiments performed on the insensible arm and the hysterical eye, defends the hypothesis of double consciousness against the theory of unconscious automatic action, and discusses various topics connected with his general subject.

A pamphlet manual of *Invertebrate Dissections* has been published by Prof. *Henry L. Osborn*, of Hamline University, St. Paul, Minn. (price, 40 cents). It tells what parts are to be observed and where to look for them in each specimen. The creatures chosen for dissection are readily obtainable, and include the sponge, various hydroids, coral, star-fish, angle-worm, crayfish, etc., ending with the grasshopper. The author states that the accounts of type specimens contained in this manual are incomplete, and should be supplemented with details of anatomy, embryology, paleontology, etc., gathered from reading or lectures.

A lecture on *Organic Evolution* delivered by Prof. *Samuel E. Tillman* at the United States Military Academy has been printed at the Academy Press. It presents those general facts concerning evolution in the domain of life that every intelligent person should be acquainted with, and in a manner well calculated to arouse the interest and hold the attention of hearers or readers. This lecture has been pronounced by good judges a most satisfactory summary of the great doctrine with which it deals.

A useful book for the phonetic teaching of reading is *A Sound-English Primer*, by *Augustin Knoflach* (Stechert, 25 cents). Its plan is to teach children first how to read phonetic print, and then, using this knowledge as a stepping-stone, to impart the ability of reading the ordinary spelling. The author's scheme of phonetic spelling recognizes six long and six short vowel-sounds, the long vowels being distinguished by doubling the letters. No new letters are employed; *q*, not being needed as a consonant, is used for the sixth vowel, and six digraphs are used for consonants that have no single letters to represent them, namely, *ch*, *sh*, *zh*, *th*, *dh*, and *ng*. A notable feature of this system is that it indicates accent. In words in which it does not conform to a simple rule, the accent is marked either by a diacritic or by doubling a consonant. Prefixed to the book is an account of a test of this mode of teaching made last summer with a part of Mr. Knoflach's manuscript. In a little over three weeks a six-year-old boy, who had never had any instruction in reading before, was made able to read a large portion of an ordinary primer. Mr. Knoflach's book has clear print and is of convenient size.

No. 3 in the series of pamphlets on North American Fauna, issued by the Department of Agriculture, embraces the *Results of a Biological Survey of the San Francisco Mountain Region and Desert of the Little Colorado, Arizona*, by *C. Hart Merriam* and *Leonhard Stejneger*. It contains a general description of the region and annotated lists of the mammals, birds, reptiles, and batrachians found therein, with a few notes on the forest trees that are common in that locality. The skulls and dentition of many of the animals are figured, and there are also colored maps showing the distribution of forest trees about the mountain.

In an essay on the *Origin of Plane Trees*, reprinted from the American Naturalist, Prof. *Lester F. Ward* criticises a paper by Prof. Johann Jankó on the same subject. Jankó excludes from the genus certain American species that had not before been challenged, and ignores others; but the chief point that Prof. Ward urges against him is that he has overlooked the significance of the basal lobes that occur on the leaves of some species.

Among the results of Prof. *Angelo Heilprin's* study of *the Geology and Paleontology of the Cretaceous Deposits* of Mexico, made during his expedition to that country in the spring of 1890, are the conclusions that the deposits, covering or scattered over a large part of the country, are continuous with the Cretaceous area of the interior basin of the United States; that they are a part of the Middle or Upper Cretaceous series; that no true Lower Cretaceous beds have been so far identified in Texas or Arkansas; and that no marine deposits of unequivocally Lower Cretaceous age have thus far been determined in the United States east of the Rocky Mountains.

Pilot Knob; a Marine Cretaceous Volcano, of which Prof. *Robert P. Hill* has published a study, is one of a group of hills composed of igneous rock standing a few miles southwest of Austin, Texas. From its structure, as studied by the author, it appears to be the neck of an ancient volcano which rose out of and deposited its *débris* in the deep water of the Upper Cretaceous sea. From its isolated position it must have been an isolated eruption. The hill probably belongs to a great chain of igneous localities, eruptive and basaltic, extending from the mountains of northern Mexico to the Ouachita system of Arkansas.

The Account of the Determination of the Mean Density of the Earth by Means of a Pendulum Principle, by *J. Wilsing*, of Potsdam, has been translated and condensed for the Smithsonian Report by *J. Howard Gore*. The value found by Mr. Wilsing is 5·579 ± 0·012.

A second edition, revised and enlarged, is published by Blakiston, Son & Co. of *Leffmann and Beam's Examination of Water for Sanitary and Technical Purposes*. The more recent methods of water analysis may be found in this volume, including those recommended by the Chemical Section of the American Association for determination of nitrogen in ammonium compounds, for nitrates and nitrites, and for oxygen-consuming power. Attention is called by the authors to the application of the Kjeldahl process in ascertaining the total organic nitrogen. The media and manipulation of biological examinations are amply treated, and a chart is given of the culture phenomena of the more important microbes. Much value is not attached, however, to the results thus obtained, since the number of microbes may vary greatly without analogous variation in the healthful character of the water. Ordinary filtration is shown to increase the micro-organisms, which develop finely in the pores of sand or stone filters. The Bischof and the Pasteur filters are to be preferred for household use, while the Anderson process of agitating the water with fine particles of cast iron in a rotating cylinder produces a water of high organic purity with great rapidity. The text is clear and well arranged, all required apparatus is illustrated, and useful analytical tables are furnished for comparison.

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POPULAR MISCELLANY.

School of Applied Ethics.—An institution with the above name is to hold its inaugural summer session, at some point on the sea-shore near Boston, during six weeks beginning early in July. The department of economics will be in charge of Prof. H. C. Adams, of the University of Michigan. He will treat of the history of industrial society in England and America; President Andrews, of Brown University, will discourse on the evils of our industrial system, and discuss proposed remedies. Prof. Taussig, of Harvard, will lecture on co-operation; Hon. Carroll D. Wright, on factory legislation; Prof. J. B. Clark, of Smith College, on agrarian questions; Albert Shaw will describe the housing of the poor in London and Paris, and examine General Booth's "Way out." Labor and industrial legislation in Europe will be treated by Prof. E. J. James, of the University of Pennsylvania. Mr. Henry D. Lloyd, of Chicago, is expected to present two chapters in the industrial history of the United States. Prof. C. H. Toy, of Harvard, will have charge of the department of religious history, for which he has enlisted a corps of eminent scientific lecturers. Prof. Felix Adler, of New York, who is the originator of the school, will preside over the department of ethics. His lectures will treat of personal and social ethics; the ethics of the family, the professions, politics, friendship, and religious association. Criminal and temperance legislation, and questions of like importance, are to be presented by other lecturers. The terms for the whole course are but ten dollars. Detailed information may be had from the dean, Prof. H. C. Adams, 1602 Chestnut Street, Philadelphia, Pa.

The Floods of the Amazons.—All the mighty tributaries of the Amazons west of the Madeira and the Rio Negro, according to Dr. P. Ehrenreich, present the same characteristics—viz., a course twisted into innumerable curvings, an uninterrupted navigability over many hundreds of miles, and low banks inundated during a great part of the year by high waters. The forest vegetation is remarkably luxuriant, and the India-rubber plant grows in the utmost profusion. Another characteristic feature of these rivers is the continual change in their course. The high water of the rainy season, exceeding by from fifty to sixty-five feet the low level of the dry season, under-washes the banks; the masses of soil thus detached are again deposited at the next bends of the river, and contribute in diverting the stream from its bed. In this way a labyrinthine system of canals arises, which accompanies the river along its whole course—the so-called *igarapés*. The old bends of the river, half or wholly shut off, form lagoons, which serve as mighty reservoirs and draw off immense quantities of water, so that the *régime* of high waters commences in the lower basin much later than in the upper part of the river. At the head-waters of the river the water-level is wholly dependent upon the rainfall in the Cordilleras; it rises and falls very suddenly, so that it not unfrequently happens that the steamer is obliged to be set right about quickly on account of the falling waters, if indeed it does not become stranded for a long time.

Hypnotism as a Therapeutic Agent.—A discussion of hypnotism as a therapeutic agent was held at a recent meeting of the Islington Medical Society, London, when Mr. Pridgin Teale and other speakers described some phenomena which they had witnessed. They were followed by Sir Andrew Clark, who characterized hypnotism as a "distortion of the partial sight of truth," and predicted that, like mesmerism years ago, it would have its day and follow into desuetude. Seeking for the physiological truth contained in the subject, he looked for the groundwork of many of the phenomena in the relation of will to the body. The communication of the will with the body, he said, brings about wonderful changes in it; and, independently of will, there is the exercise of attention, of expectation, and of concentration; and we know that without the introduction of any foreign agency—that is to say, the agency of any other person—attention, expectation, and concentration of will operating together bring about most remarkable results in the human body. There are many homely illustrations of this fact—as when one has a headache which disappears on the coming of some unexpected visitor, to return as soon as he is gone, or when a patient is relieved on the administration of a bread-pill. The speaker himself had been so interested in looking at a microscopic object that people had come into his room and spoken to him, and he had not heard or seen them. Looking at these physiological conditions, a great many things can be brought about which are described as being induced by the agency of another person. The speaker estimated the frequency with which such agencies can be made successful as in inverse proportion to the development of the higher ganglia. People are influenced by them in the inverse order of their intellectual faculties, and in the direct order of the automatic activities of the brain; hence the range in which such phenomena are capable of being seen and produced is practically what is called the neurotic range. This includes people whose nervous systems are movable, excitable, sensitive, irritable, or explosive. All such people are capable of manifesting phenomena which are brought about by attention, expectation, and concentration; and we find, too, that all these phenomena occur in people with a lowly developed nervous system, which is to a great extent automatic, and is manifestly enforced by emotion. The hypnotic phenomena which are related were supposed to be capable of explanation on the simple physiological grounds thus laid down, without the introduction of any person exercising a mysterious power.

Scenery of Yellowstone Park.—The merits of the scenery of Yellowstone Park appear to Prof. G. F. Wright to have been considerably exaggerated. He rode through it under favorable conditions for observation, but found his trip, on the whole, disappointing. The figures representing the height of the mountains around it above the sea are deceptive. A mountain 10,000 or 11,000 feet high does not look extraordinarily large and massive when it rises not more than 2,000 or 3,000 feet above the elevated plateau on which it stands as a base; but those 2,000 or 3,000 feet are all that is shown of the mountain-rim of the park, while the glimpses to the outside mountains are few and far between. The grandest views are those on entering the park as one looks outward from the encircling rim. "Those who reside in the Atlantic States do not need to go to the Rocky Mountains for scenery." Even Dr. Hayden acknowledged this substantially after he had been to the Crawford Notch. "He who has seen the Adirondacks and the White Mountains has seen some of the best artistic effects of which Nature is capable. Even he who has looked over the parallel ranges of Pennsylvania has no need to pine for the mountain scenery of the Yellowstone Park." The beauty of the Yellowstone Cañon, however, with its unique combinations of rock-carving and variegated color, which "artists are put to shame in their attempts to imitate," can hardly be surpassed. The geysers, Prof. Wright says, in the Boston Congregationalist, "are decidedly vulgar, and one can afford to die without seeing them. Boiling paint-pots, with only one dull color in them, are not inspiring. Acres of land laid waste by sulphurous waters and gases, such as greet one on every hand in these geyser basins, can be seen at any time in Pennsylvania where the refuse water is pumped from the coal-mines to spread its desolation all around. The Upper Geyser basin, with its score or more of steam-jets, looks from a distance like a flourishing manufacturing town. The odors can be matched in the calico-printing mills. The geysers differ from steam fire-engines in throwing hot water instead of cold; and even the Excelsior is not as impressive as the ocean surf of the New England coast." But the author thinks that the scientific interest of the park can hardly be exaggerated.

Mosquito-inoculation against Yellow Fever.—Statements are made by two physicians of Havana (Drs. Finlay and Delgado), in the medical journal of that city, concerning their practice of inoculating persons newly arrived in Cuba against yellow fever by means of mosquitoes which have been caused to contaminate themselves by stinging a patient afflicted with that disease. The observations have been carried on for ten years, and relate to fifty-two cases of mosquito-inoculation which have been followed out, and others which are still incomplete. Of the cases, twelve experienced between the fourth and the twenty-sixth day of inoculation a mild attack of yellow fever; twenty-four experienced no symptoms within twenty-five days, but contracted a mild attack before the end of three years; twelve exhibited no symptoms of the disease within three years; three, who had no symptoms within twenty-five days, contracted well-marked yellow fever within three years; and one, who had a mild attack in consequence of inoculation, contracted a severe attack later on which proved fatal. Thus only eight per cent of those who had been inoculated contracted the disease in a well-marked form, and the mortality was less than two per cent. Of sixty-five monks who came to Havana and lived there under similar conditions, thirty-three were inoculated and thirty-two were not. Only two of those who were inoculated had well-marked attacks, and these were not fatal; while eleven of those who had not been inoculated were severely attacked, and five died. But inoculations performed in cold weather do not seem to be wholly trustworthy and need to be repeated in the spring; also it appears that a person who has been three years in the city without having the disease has become acclimatized, and is not likely to be attacked afterward.

Facts about the Aurora Borealis.—The present condition of the investigation of the phenomena of auroras is thus described by Mr. G. S. Griffiths, F. G. S., F. R. S., in an address on the objects of antarctic exploration. The nature of auroras, the author says, is very obscure; but recently a distinct advance has been made toward discovering some of the laws which regulate them. "Thanks to the labors of Dr. Sophus Tromholt, who has spent a year within the Arctic Circle studying them, we now know that their movements are not as eccentric as they have hitherto appeared to be. He tells us that the aurora borealis, with its crown of many lights, encircles the pole obliquely, and that it has its lower edge suspended above the earth at a height of from fifty to one hundred miles, the mean of eighteen trigonometrical measurements, taken with a base-line of fifty miles, being seventy-five miles. The aurora forms a ring round the pole, which changes its latitude four times a year. At the equinoxes it attains its greatest distance from the pole, and at midsummer and midwinter it approaches it most closely; and it has a zone of maximum intensity which is placed obliquely between the parallels of 60° and 70° north. The length of its meridional excursion varies from year to year, decreasing and increasing through tolerably regular periods, and reaching a maximum about every eleven years, when, also, its appearance simultaneously attains to its greatest brilliancy. Again, it has its regular yearly and daily movements and periods. At the winter solstice it reaches its maximum annual intensity, and it has its daily maximum. . . . Whether or not there is any connection between auroral exhibitions and the weather is a disputed point. Tromholt believes that such a relationship is probable. He says that 'however clear the sky, it always became overcast immediately after a vivid exhibition, and it generally cleared again as quickly.' Payer declares that brilliant auroras are generally succeeded by bad weather, but that those which had a low altitude and little mobility appeared to precede calms. Ross remarks of a particular display that 'it was followed by a fall of snow, as usual.' Scoresby appears to have formed the opinion that there is a relationship indicated by his experience. It is, therefore, allowable to regard the ultimate establishment of some connection between these two phenomena as a possible contingency. If, then, we look at the eleven-year cycle of auroral intensity from the meteorological point of view, it assumes a new interest, for these periods may coincide with the cycles of wet and dry seasons which some meteorologists have deduced from the records of our Australian climate, and the culmination of the one might be related to some equivalent change in the others. For, if a solitary auroral display be followed by a lowered sky, surely a period of continuous auroras might give rise to a period of continuous cloudy weather, with rain and snow. Fritz considers that he has established this eleven-year cycle upon the strength of auroral records extending from 1583 to 1874, and his deductions have been verified by others."

Function of Cypress Knees.—The cypress tree (*Taxodium distichum*) of the Southern swamps is marked by a peculiar growth of protuberances rising above the soil in the region of the roots, and called knees. The purpose of the knees has not been satisfactorily determined. They have been regarded by botanists as simply affording a means for securing the aëration of the sap when the roots are too deeply covered with water to permit them to serve that purpose. Mr. Robert H. Lamborn, after examining the trees in the swamps, has come to a different conclusion. He believes that the knees secure a firm hold to the tree in the exceedingly loose soil in which it grows. The formation of knees is accompanied by roots projecting more or less perpendicularly into the earth. The knee, when fully developed, is generally hollow, comparatively soft, gnarled, and hard to rupture, so that it has the quality of a spring that becomes more rigid as it is extended or compressed out of its normal shape. "When, in a hurricane, the great tree rocks back and forth on its base, and with its immense leverage pulls upon this odd-shaped wooden anchor, instead of straightening out in the soft material, as an ordinary root might, thus allowing the tree to lean over and add its weight to the destructive force of the storm, it grips the sand as the bower-anchor would do, and resists every motion. The elasticity at the point of junction allows one after another of the perpendicular flukes attached to the same shank to come into effective action, so that before being drawn from the sand or ruptured the combined flukes present an enormous resistance." The knees, with their sharp tips, may also serve the purpose of catching the drift of plant-food as it floats on the currents of floods, and effecting its deposition. Mr. Lamborn adds, in his articles in Garden and Forest and the American Naturalist, an observation regarding the roots of other trees that trench upon soils affected by the cypress, and often take advantage of the anchors it sets in treacherous bottoms. They project their cable-like, flexible roots in every direction horizontally, interlacing continually until a fabric is woven on the surface of the soft earth like the tangled web of a gigantic basket. Out of this close wickerwork, firmly attached to it, and dependent for their support upon its integrity, rise the tree trunks. Thus slowly, and by a community of growth and action, a structure is formed that supplies for each tree a means of resisting the storms. Such communities of trees, provided with ordinary roots, advance against and overcome enemies where singly they would perish in the conflict.

The Chigger.—Dr. H. M. Whelpley has published two papers on the chigger (*Leptus irritans*), an insect which is very troublesome to blackberry-pickers in the Mississippi Valley. It has no relation to the chigoe (*Pulex penetrans*) of South America, which resembles the fleas, while this insect is like the ticks. It is found in the Eastern and Southern States as well as in the Mississippi Valley, but has not been reported north of the fortieth degree of latitude, and does not seem to thrive in the far West. Besides human beings, it attacks the house-fly and is very troublesome to young fowls, where the parasites collect in lumps as large as a pin, and cause death, with the symptoms of poisoning by strychnine. Some persons are more susceptible to its attacks than others. Some specimens of the insect are almost transparent, but they all become darker in color as they become gorged with blood. Several remedies are prescribed for the living chiggers and for the sores they cause. Among them are kerosene and spirits of camphor.

Malays and Negritos of Malacca.—In his account before the Anthropological Institute of the races of the Straits Settlement (Malacca), Mr. Swettenham, of the Settlement's Civil Service, assumed that the Malays are not indigenous to the peninsula; but the exact place of their origin has not been established. According to their own traditions, they are of supernatural origin, and crossed over from Sumatra. Until about A. D. 1250 they were pagans or Hindooists, but near that time they came under the influence of Mohammedanism. The Perso-Arabian characters were introduced then, while the language had not previously been written. Relics of Hindoo superstition still exist among the Malays and Negritos of the peninsula, and customs that savor strongly of devil-worship. The author would classify the Negritos into the Sakai and the Samang. The Sakai are a people of moderate stature and large bones, fairer in complexion than the Malays, with long, wavy hair standing straight out from their heads. The Samang are small and dark, with black, frizzy hair close to their heads, like that of the negro races. Some writers have inferred, from comparison of languages, that there are connecting links between the Negritos of various tribes and the Malays, and believe that the former show traces of Melanesian blood.

Massage in Ancient Times.—Massage has apparently been practiced from the very earliest times. A Chinese manuscript of three thousand years before the Christian era contains an account of operations very similar to those which go under that name at the present time—friction, kneading, manipulating, and rolling. A form of massage was the common accompaniment of the bath with the Egyptians, Greeks, and Romans, and was used as a luxury, a means of hastening tedious convalescence, and of making the limbs supple and enduring. Hippocrates commended it; Esculapius believed in it; Cicero affirmed that he owed as much of his health to his anointer as he did to his physician; Julius Cæsar had himself pinched all over every day for neuralgia; and Pliny enjoyed great benefit from it. Celsus advised rubbing to be applied to the whole body; and the works of Plato abound in references to the use of friction. Peter Henrik Ling is said to have based the Swedish movement-cure on the Chinese Kong-Fan manuscript. Lepage relates that the Chinese massage was a particular practice borrowed from the Indians, and that it was by such means that the Brahmans effected their miraculous cures. The method is common among the Polynesians, and something like it was found among the Australians.

Decay of India Rubber.—Mr. W. Thomson says, in a paper on the vulcanization and decay of India rubber, that copper salts have an injurious effect on India rubber, and, as that metal is sometimes used in dyeing blacks and other colors, cloth so dyed is liable to decompose and harden the rubber put into it. Metallic copper placed in contact with thin sheets of India rubber brings about oxidation and hardening of its substance, although no appreciable quantity of copper enters the India rubber; but metallic zinc and silver have no injurious effect on the rubber. The author had found that if oil containing a certain amount of copper, which it often does, gets on the cloth, the action of the bleaching agents on the copper damages the cloth. There is an acid in ordinary linseed oil that rots cloth. The smell of India rubber is one of the characteristics of its decomposition. When a piece of blotting-paper is placed over decaying rubber, it becomes colored by some of the emanations, as does not occur with good rubber. There is therefore no doubt that certain volatile substances are emitted during the oxidation that produces the hardening of India rubber. Rubber can be kept best under water or glycerin, or in coal-gas. It remained good when placed in a vacuum and exposed to sunlight for twelve months. All oils, except castor oil, have a detrimental effect on India rubber.

Cancer and Nervous Disease.—In an article in the Nineteenth Century, Mr. Herbert Snow shows that mortality from cancer in the United Kingdom is increasing at an accelerating rate, and that the disease is of nervous origin. According to the Registrar-General's returns, the aggregate mortality from this disease in England and Wales has grown, during the twenty-five years 1864–1888, from 8,117 to 17,506 a year. In proof that the increase in mortality can not be adequately accounted for by the growth of population, the tables are again invoked to show that the mortality from cancer per million persons living has risen during the same period from 385 to 610. The increase, year by year, has been very regular. Returns of a like character from Ireland and Scotland tell the same story. Dr. Fordyce Barker is quoted as having shown that the number of deaths per million in New York rose from 400 in 1875 to 530 in 1885. Cancer may be and often is initiated by direct mechanical injury or irritation; "but in by far the larger proportion of those varieties of cancer which furnish the bulk of the mortality statistics no such mechanical exciting cause can be detected." Moreover, as no additional liability to local injury or irritation now exists than formerly, it is necessary to seek another cause for the increase of cancer. "When we investigate the personal history of cancerous persons, it is impossible to avoid being struck by the large number who speak of antecedent trouble, worry, or mental anxiety. In particular, the face of the average woman sufferer—care-worn, thin, and anxious—constitutes a type well known at every general hospital." The reason of the supposed connection can not be explained; "but the immediate sequence is a matter of daily familiarity, insomuch that it may be laid down as an axiom wherever the antecedents of any major cancerous growth are to be investigated, 'Failing a mechanical exciting cause, a neurotic is always to be found'; provided only that sufficient evidence of previous history and surroundings is procurable. Moreover, it is to be noted that the female, the more neurotic and emotional sex, are the principal sufferers from cancer; also that the organs in them by far the most prone to diseases of this class are normally, in health, specially and peculiarly influenced by emotional conditions, and by states of the central nervous system." The author has made some inquiry into possible hereditary transmission of cancer, but failed to find a sufficient proportion of cases of hereditary connection to justify his including that among general controlling causes.

Fine Quartz Fibers.—In a lecture on quartz fibers and their applications, Prof. C. Vernon Boys began by explaining that the physicist in making his experiments has often to deal with very small forces, which are sometimes measured by the direct pull they exert, and sometimes by the twisting effect they can produce when applied at the end of an arm acting as a lever. It is often necessary to be able to detect and measure forces not larger than the weight of a millionth or even of a thousand-millionth of a grain. If these are used to produce a twist in a wire, the wire must be exceedingly thin for the twist to be measurable. A wire when reduced to one tenth of its original thickness will only require one ten-thousandth part of the force to twist it by the same amount; and, consequently, we can measure forces as small as we please if we can only get wires thin enough. Formerly experimenters made use of metal wires, but these were soon replaced by fibers of spun glass, which can be got far finer. Glass, however, has one great drawback, in that it will not, when twisted, return to its original position after removing the twisting force, but acquires a permanent twist, and this renders it very difficult to use in delicate instruments. If we want finer wires we must turn to the single fibers obtained from the cocoons of silk-worms. These are so fine that in ordinary instruments the force required to twist them is so small as to be considered quite negligible. Some three years ago the lecturer constructed an instrument (radiomicrometer) to measure the difference in the amounts of heat radiated from different parts of the disks of the sun and moon. In this instrument it was necessary to measure a force so excessively small that even a silk fiber was too coarse. He therefore endeavored to obtain finer wires by shooting a very light arrow, which drew after it a very fine fiber of quartz from a piece of molten quartz held in the flame of an oxyhydrogen blowpipe. In this manner a thread of quartz can be obtained which is not more than one fifteen-thousandth of an inch in diameter, and which will show an appreciable twist with a force of a thousand-millionth of a grain weight applied at the end of a lever one inch long. The lecture was illustrated by a number of experiments.

Consumption Germs.—Speaking at the Sanitary Convention in Vicksburg, Miss., of December, 1889, Dr. A. Arnold Clark, of Lansing, Mich., accepted the germ as the chief source of the disease, and referred to experiments in which the germs had been found on the walls of rooms where consumptives had been; they are derived from the dried sputa of the patients. Animals, according to Dr. Cagny, feeding on the sputa die of consumption; and the disease has been produced by inoculating with the sputa, by swallowing it, and by breathing it. "When we think of the ten thousand consumptives in Michigan who every hour in the day are expectorating along our streets, and even on the floors of public buildings, post-offices, churches, hotels, railroad cars, and street cars; when we think how these germs are being dried and carried into the air by every passing breeze, by every sweeping, and how they are capable of producing the disease six months after drying; when we think of the miscellaneous crowd sleeping in hotel bedrooms; when we think of the close, unventilated sleeping-car with hangings and curtains so well calculated to catch the germs, and where, as some one has said, the air is as dangerous as in those boxes filled with pulverized sputa where dogs are placed for experiment; then when we remember that man's lungs are a regular hot-house for the multiplication and growth of these seeds of consumption—is it any wonder that one citizen in every seven dies of this disease?" As the lesson from these facts, the author advises that no consumptive should be allowed to expectorate on the floor or street, and all sputa (from consumptives) should be disinfected and burned.

Characteristics of Leprosy.—The etiology of leprosy has been studied in Cashmere by Dr. Ernest F. Neve. The disease may be recognized in its early stages by certain integumentary changes, or by anæsthetic patches. The skin of the forehead, especially of the superciliary ridges, becomes somewhat thickened and dusky in color, but not necessarily irregular. The hair of the eyebrows is scanty. There are two main types of leprosy in the valley—the anæsthetic and the tubercular; but patients may often be seen presenting at once anæsthesia, macules, tubercles, and ulcerations of soft tissues and bone. Anæsthesia seldom remains for any length of time uncomplicated. Blisters are apt to form, and then local death of tissue and ulceration. Portions of bone removed by operation in the more advanced stages are spongy, and appear to have undergone a process of rarefying osteitis. Withdrawn nerve-influence is greatly concerned in the affection; and the nerves supplying the degraded part are found, on clinical examination, to be thickened and sometimes tender. The nerves most often involved in leprosy are, in order of frequency, the sciatic, musculo-spiral, ulnar, and median. The changes in the reflexes are essentially of the nature of diminution. Superficial reflexes disappear early. Muscular atrophy occurs in advanced cases. The tubercular form is apt to be more severe than the anæsthetic, and is often superadded. The face becomes distorted, with elevations a few lines in diameter, especially affecting the forehead, nose, and auricles, producing the characteristic leonine appearance, but scattered over the whole body. In treatment, nerve-stretching has been found valuable as a palliative.

A Sacrifice to the Yankee Pie Idol.—There is a belief, in other parts of the country, that the New England digestion has been sacrificed to pie; but few persons, probably, have known of other valuable possessions being offered up to the idol. In a biographical sketch of Charles Chauncy, second President of Harvard College, written in 1768 by his great-grandson of the same name, the writer states that, desiring to possess the papers of his illustrious ancestor, he made a search for them and found that they had descended to a son of the president, "who had kept them as a valuable treasure during his life; but upon his death, his children being all under age, they were unhappily suffered to continue in the possession of his widow, their mother. She married some time after a Northampton deacon, who principally got his living by making and selling pies. Behold now the fate of all the good president's writings of every kind! They were put to the bottom of pies, and in this way brought to utter destruction."

Mangoes.—Hundreds of varieties of the mango are grown in India; and, according to Dr. G. Bonavia, fifty or more kinds might be named which for texture and exquisiteness of flavor would more than compare with the same qualities in the nectarine and peach. Only those who have had opportunities of trying the choice varieties have any conception how good this fruit is. The uncultivated seedling mangoes are generally fibrous, but this does not prevent their having very often an exquisite flavor. To enjoy them they must be sucked. The choicest mangoes, of which there are scores, have no fiber in their pulp, and not a trace of turpentine flavor, except, perhaps, a suspicion of it in the skin. "When the skin is removed, if you shut your eyes while eating them, you might often be deluded into the idea that you were eating nectarines, figs, etc., and sometimes a delicious compound with a dash of mushroom flavor in it. The flavors of choice mangoes are infinite, and their size varies from that of a small hen's egg to that of a good-sized melon or ostrich-egg. A choice mango can be scooped out with a spoon, and it has the texture of a stiff curd."

Cultivation of Alpine Plants.—An Alpine botanical garden for the cultivation of mountain plants has been established in Valais, under the auspices of the Association for the Protection of Plants, and was opened on the 21st of July, 1889. It includes about a hectare of land, and is situated at the height of 1,633 metres above the sea, above the village of Bourg-Saint-Pierre in the Val d'Entremont, on the Great St. Bernard road, and some three or four hours from the Hospice. The tract consists of a hill about sixty metres high, and presents the variety of soil and slope, of wet, dry, and stony tracts that promise to be best adapted to the wants of the various species that will be planted upon it. It is called the Linnæa, and has been placed under the special care of an international committee, whose headquarters will be at Geneva. M. Arthur de Claperède, of Geneva, has been chosen president of this committee; and Dr. Balley, of Bourg-Saint-Pierre, vice-president. Among its twenty-five members are Sir John Lubbock and Mr. G. J. Romanes. Visitors not members of the protecting societies of the institution will be charged fifty centimes for admission to the grounds, and perpetual tickets will be issued to those making gifts of ten francs or more.

Climatic Conditions of the Glacial Period.—According to Prof. Warren Upham's paper on the climatic conditions of the Glacial period, the formation of the great ice-sheet should be promoted by long-continued rather than an excessive cold, and an abundant supply of moisture by storms, giving plentiful precipitation of snow during more of the year than now, so as to include in the time of snow accumulation not only the present winter but also the autumn and spring months. The summers, too, were probably cooler in glacial times than now, for their heat was not sufficient to melt away the accumulated snow, which gradually increased in thickness from year to year, its lower part being changed to ice. When large portions of continents became thus ice-coated, the storms sweeping over them would be so rapidly cooled that the greater part of their snow-fall would take place upon the borders of the ice-sheet, within probably from fifty to two hundred miles from its margin; but the snow-fall during the advance of the ice was probably in excess of the amount of evaporation and melting over the whole ice-covered area. In New England and New York the average ascent of the ice was from twenty-five to thirty feet per mile for the first one hundred to two hundred miles from its boundary. Toward its center the slope diminished, as on the interior ice of Greenland; but the ice-sheet enveloping the north-eastern part of North America probably attained, as estimated by Prof. Dana, a maximum thickness of about two miles on the Laurentian highlands between the river St. Lawrence and Hudson Bay.

Cocoa.—Cocoa in its natural state contains a large proportion of fat, so that it can not be taken by persons suffering from weak digestion. The presence of so mnch fat prevents the easy solution of the naturally soluble portions, which are more or less locked up in the fat. This difficulty was encountered and overcome by the Indians and Mexicans in the same way as our cocoa manufacturers first overcame it—by adding to the powdered cocoa sugar and starch as diluents. Or a considerable part of the fat can be removed by pressure. Chemical analysis has shown that the estimation in which cocoa was held by the inhabitants of the countries in which it was first produced rested on scientific as well as on practical grounds. Our manufacturers are working now on the same lines as did the natives of Central America three hundred years ago, and the additions they make to cocoa are only imitations of what was done in ancient times to make its use more acceptable. As compared with tea and coffee, cocoa is deficient in those aromatic properties which have an exciting effect on the nerves of taste and smell. It has about as much of alkaloids as coffee, but they do not exert an equal stimulating effect. It is, however, rich in such elements of a perfect food as fat, albumen, and starch, and has nearly twice as much mineral salt as tea. To obviate the unpleasant effects of the fat, a large amount of it is removed, or diluted, during the process of manufacture. When deprived of the excess of fat, cocoa yields a bland, easily digested, and slightly stimulating beverage, which is generally free from any subsequent unpleasant effects.

New Tests for Color-blindness. — The method of testing the eyes of railway servants by skeins of differently colored wools has been pronounced by the Congress of the Society of Drivers and Firemen unpractical, because the conditions under which it is made are different from any to which the men are subjected in their work. The congress has recommended that the men be tried day and night on the railway with actual signals at any necessary distances; and have suggested that, in any case in which a member of the society is discharged or reduced on account of failure in responding to the dot and wool test, he should be examined by a surgeon, with the right to have a practical trial with signals if the surgeon's report is not unfavorable. The Lancet suggests that there are other cases where a surgeon's examination may be in place—when, for instance, a man's eyesight fails after he has been on duty sixteen, eighteen, or twenty-three hours. Again, a man may have impaired his vision by excessive smoking.

Choice Oriental Fruits.—It has been said that more than a hundred different preserves could be made from a judicious blending of the fruits of the East and West Indies and of South America. The Indian preserves were formerly in much request. In the thirteenth century the most renowned preserve was a paste made of candied ginger. In India preserves and jellies are made of the pear, quince, mango, tamarind, date, guava, banana, etc. In Singapore pineapples are preserved whole, and the same manufacture is carried on on a large scale in the Bahamas. Among other fruits preserved in their natural state, in sirup crystallized with sugar, or made into jelly, are the pineapple, bread-fruit, ginger, jack-fruit, papaw, mangosteen, pomeloe, and nutmeg. Preparations of pineapple are among the best of these. Both the red and white guava make excellent sweetmeat paste or jelly. Bread-fruit, whether in sirup or crystallized, is flavorless to the European taste, and more a food-substance than a fruit. Preserved ginger is popular in England, but is not much esteemed on the Continent. The Spaniards eat raw ginger in the morning to give themselves an appetite; and it is used at table, fresh or candied. Among sailors it is considered anti-scorbutic. The mangosteen is one of the most delicious and famous fruits of the Indian Archipelago, and has the "delicate and characteristic flavor of the strawberry, grape, pineapple, and peach, combined." The mango is the best fruit of India, and is cultivated in about as many varieties as the apple. The half-ripe fruits are made into tarts and marmalades. The finest varieties seem to thrive in Jamaica, where the mango is a popular fruit with the negroes. The list of Oriental fruits available for preserves is long and contains many names hardly known, except as matters of curiosity, in the West.

Fishing for Crocodiles.—The Sundyaks, or Dusuns, of the east coast of Borneo, eat crocodiles, and fish for them. According to Mr. R. T. Pritchett's description of their mode of fishing, they bind a dead monkey as bait upon a stick, along which, at intervals, are tied lengths of fishing-twine. These are brought together some seven or eight feet off, and attached to the end of a rattan seventy or eighty feet in length. The bait is thrown into the river at a suitable spot, and the other end of the rattan is slightly secured to an overhanging branch. The crocodile takes the bait, and retires to enjoy and digest his meal, paying no attention to the stick. The hunter, going to the river the next morning, and missing his rattan, looks along the river till he finds it floating on the stream; the crocodile is of course at the baited stick. The hunter takes the rattan and with a sharp jerk upon it draws the stick "athwart-ship" in the interior of the crocodile. The rattan is pulled on shore as quickly as possible, and, with the help of as many of the hunter's friends as may be required, the crocodile is disposed of. The professional sportsmen, it is said, address their captive, when they first get him on the line, with different titles of honor, after the manner of the ancient Egyptians, believing that the reptiles have grades and ranks, and gradually going down the scale till he is landed, when they call him very hard names.

Gutenberg and the Art of Printing.—The credit of the invention of printing in Europe appears to have been settled upon Gutenberg by the publication of a letter written by Guillaume Fichet, in 1470, only two years after Gutenberg's death, to Robert Gaguin, which has recently been found in the unique copy of the Liber Orthographiæ of Gaspar Barzilius, the second book printed in Paris, in the library of Basle. In this letter Fichet says, "They report that not far from the city of Mentz there was a certain Jew surnamed *Bone-montanus* (Good-mountain, Gutenberg), who first thought out the art of printing." The writer then dilates upon Gutenberg's superiority, in virtue of his invention, to the ancient gods and goddesses, benefactors of humanity, and concludes, "Nor will I be silent concerning those who already surpass their master, among whom Udalricus, Michael, and Martinus are said to be chief." The invention may have been original or not with Gutenberg, but this was not the first of it. The art of printing with movable types was known to the Coreans before it was practiced in Europe. The British Museum possesses several Corean books so printed, which, in the opinion of experts, are of earlier date than the middle of the fifteenth century. The same people afterward fell back into block printing.

Modes of Hoarding.—The passion for hoarding is an old one, and is naturally developed. All people love what is bright, like gold and jewels, and when it is not safe to use treasure openly, will hide it. The attribute of value, soon acquired by such objects, increases the desire to possess and keep them. The Indians, not having much stock of precious metals, laid up wampum-belts. The Celts and Goths rolled gold into spiral finger-rings, or made necklets, armlets, and bracelets of it to wear. The ancient Egyptians had their ring-money, and treasure-houses where it was kept. The Greeks deposited their money in temples, buried it in the ground, or laid it away in tombs. Many people simply bury it; and this custom is illustrated in the fairy and mythological tales of buried treasure. Hoarding seems to have been more extensively practiced in India than in any other country. It was stimulated there by the rapacity of all governments previous to the English. The efforts of the English to change the habits of the people, by establishing banks and facilities for circulating money with guarantees of security, have had only partial success. The Royal Commission on bimetallism estimates that the hoards of the last fifty years in that country represent about three hundred millions sterling of gold and silver, or nearly one third of the total value of the coin in circulation in the world. The hoards of past centuries must be added to these to get the full amount. The metal is laid up in the form of bullion or coin, ornaments, or jewelry, and it would be hard to say which form is preferred. Jewelry is prized highly, and always finds ready sale. British sovereigns are in favor, because of the image of St. George and the Dragon upon them, which appeals to religious motives. The hoards of some of the native princes are enormous. The treasure of the Maharajah of Burdwan occupied half a dozen or more large rooms and vaults. These hoards acquire in time a sort of sanctity as a family treasure, and it becomes a point of honor not to break into them; so that they are not drawn upon except in extreme cases. Hoarding is common among the thrifty peasantry of Europe; and it was by wisely using the opportunity to draw from stores thus accumulated that the French people achieved their wonderful success in paying off the war indemnity which the Germans levied upon them.

Chinese Prize Essays.—The Chinese Polytechnic Institute and Reading Rooms, Shanghai, has for several years been managing a scheme of prize essays which has expanded into considerable proportions. It is based upon the popular system of writing essays in an elevated style of composition, in which the Chinese excel to an extraordinary degree. A high official is asked to give out a subject, on which prize essays are invited, and to co-operate in the examination of the essays and the awarding of the prizes. The subjects are given out quarterly. Three highest prizes and ten smaller ones are awarded; the essays are printed in the native newspapers, and the year's essays receiving the highest prizes, with the criticisms on them, are published in a book. For the essays of 1889, three extra subjects were selected by Li Hung Chang, far beyond the range of the ordinary Chinese scholar. They were a sketch of Western science, including notices of Aristotle, Bacon, Darwin, and Spencer; the breach of international law by one country turning its back on its treaty with another, and refusing to allow the people of the other country to come and go within its boundaries; and the suggestion of a remedy for the damaging competition of Indian tea with Chinese. There were students, however, who did not shrink from undertaking them, and "many English Sinologues were greatly bored by their native friends" for information respecting the Western *savants* and their scientific teachings, "hardly knowing, perhaps, why an interest in such celebrated characters should have been so suddenly developed among the Chinese."

A Whirligig Spider.—The habit of some geometric spiders of gyrating under certain circumstances is known, and even not uncommon, but, according to correspondents of Nature, has not been described in scientific works. A *Pholcus*, abundant in La Plata, is described by Mr. W. H. Hudson as having the habit strongly marked. It has legs of extraordinary length, and the color and general appearance of a crane-fly, but is double its size. When approached or disturbed, it gathers its feet in the center of its web, "and swings itself round and round with the rapidity of a whirligig, so that it appears like a very slight mist on the web, and offers no point for an enemy to strike at. Here the correspondence between structure and habit is nearly perfect; the slimness and great length of the legs causing the creature, at the moment the swift revolutions begin, to seem to disappear from sight; and, owing to the string-like form of the legs, the fatigue experienced is probably very much less than the action would cause in a stout, short-legged spider like the English species. At all events, it can revolve for fifteen or twenty seconds at a stretch; and, if the cause of alarm continues, it will perform the action no less than three times before quitting the web. The English spider exhausts itself in a few seconds."

Impediments to Growth of Population.—In speculating upon the causes of the stationary condition of the population of France, the customs of subdividing the land and of providing dowries for girls have been cited as important factors in keeping down the increase. Abnormal mortality from small-pox and from typhoid fever is mentioned in the Lancet as another probable cause. Dr. Brouardel has pointed out that, while Germany loses only 110 persons a year from small-pox, France loses 14,000, and that the deaths by typhoid fever amount to 40,000. These facts carry the matter back to slackness in enforcing vaccination and to faults in water-supply. Dr. Brouardel concludes his paper on this subject by affirming that if vaccination and revaccination were made obligatory in France, and if the towns were everywhere supplied with pure water, the country would save from 25,000 to 30,000 lives annually, and these, for the most part, of young persons of marriageable age.

Curiosities of Marriage.—The theory of English scholars concerning the evolution of marriage is in a measure confirmed by Prof. Kovalevsky's studies in Russian ethnography. The evidence of a primitive condition of great license is, however, slight, and rests principally on the testimony of prejudiced witnesses. The evidence of a matriarchal and endogamic stage is stronger, and receives some confirmation from customs that survive among Russian peasants. The transition to marriage by capture and exogamy was general. The former practice existed in Servia and Montenegro until recent times. The growth and prevalence of the custom of purchase are shown by the wedding songs in use among Russian peasants. The Mordvins of Russia, according to the Hon. John Abercromby's conclusions, before they came in contact with the Slavs, wooed by proxy and contracted marriage by purchase, but went through the form of capturing and carrying off the bride as a proof of courage and address. The author calls this form marriage with capture instead of marriage by capture. He thinks the latter was not in use among them, while marriage by purchase may have existed among them from the polished stone age. Capture is sometimes resorted to to reduce the price of a girl or to avoid payment, but is an incident of marriage by purchase. Among the Manchus, according to a gentleman of that people, the middle-man takes a large part in arranging marriages. When he has brought the parents of the pair to an agreement, a solemn inspection of each party is made by the mother of the other, to see that the bridegroom is not dumb, the bride not lame, etc. Then cards and presents are exchanged. The marriage ceremony lasts three days. In the bridal chamber the couple are fed with "offspring dumpling" and "longevity dough"; and a "longevity lamp" is kept burning. An important ceremony is the uniting the cups, by the couple drinking wine alternately from two cups tied together by a red string. Frequently children are promised to each other in marriage while still very young.

Gypsy-carried Folk Lore.—"Gypsies," says Mr. Charles B. Leland, "have been the colporteurs of witchcraft." A hundred confirmations, the Athenæum observes, "might be adduced of the saying. It is fifty years now since old Mrs. Petulingro traveled Norfolk with her sparrow that told her all manner of secrets; to-day her descendants are camping in Scotland, Ireland, America, and New Zealand. Wherever they have wandered they have carried with them both gypsy and East-Anglian superstitions; so that you still find them counseling a Clydesdale beekeeper, who has just lost his wife, to 'tell' the bees and put crape upon his hives, practicing their own strange methods of ordeal and *tabu*, or plucking out the heart from a live white pigeon at midnight and casting it on a clear fire, as a gypsy girl did five years since, to put a spell upon her false lover. For gypsies both borrow and lend: if they gull, they are gullible, and the gentile 'wise man' has no more credulous victims. Found as they were in Finland in 1580, in Shetland in 1612, and roaming as they do from Poland to China, from Hungary to Algeria, the gypsies are a most disturbing factor in the problems of folk lore. How much they have done toward the diffusion of magic and folk tales it were hard to estimate; that they may have done very much is at least possible. Their tales present all the familiar features (of swan-maidens, forbidden chambers, the grateful dead, etc.); their superstitions in eastern Europe are often identical with those of our English peasantry—e. g., Transylvanian gypsies seek out a drowned body with a loaf having quicksilver in it. And only last summer a member of the Gypsy Lore Society discovered in Argyleshire a band of boat-dwelling 'tinklers' speaking good Romany."

Phenomena of Stream Currents.—In a paper on the flow and friction of water in open channels, read by Dr. D. T. Smith at the American Association, the questions were asked: Why are there streams? Why are the channels of streams trough-shaped? Why are streams higher in the middle than at the edges? Why is the greatest speed of streams not at the surface but at some distance beneath? Why do streams flowing into the sea through deltas have plural mouths? Why are the banks of rivers in deltas raised above the adjacent lands? Why do rivers, flowing down steep inclines, early come to an even rate of speed, and not increase in speed to the bottom of the incline as do solid bodies in falling? Why does drift move from the margins to the middle of rapid streams? Why are rivers deep just before entering the sea, yet entering with the bottom sloping upward? These phenomena, it was claimed, are all produced by movements in the water due to unequal friction. The particles of water rubbing against the sides of the channel are retarded more than those next within, and, as those outside fall behind, those next within move out and take their places, thus preserving the width of the stream. Those next within take the place of these, and so on to the middle of the stream at the bottom. As the water at the bottom moves out, that above settles down in the middle. As the water moves against the banks, it is raised up by the force with which it strikes, and the surface of the stream at this stage potentially represents a trough. The water from the edges of this trough flows back obliquely toward the middle, and by the time it reaches the middle it gains such momentum that the middle of the stream is made the highest. Every stream is by these forces resolved into two cylinders, revolving spirally on parallel axes in opposite directions—that is, outward at the bottom, upward at the edges, inward at the top, and downward through the middle. The principle is denominated "the law of the double spiral," and affords an explanation of all the phenomena in question. Since glaciers are subject to the same conditions, it is believed that they are subject to the same movements. It is believed to apply to air currents also, and that the Western blizzard and the Texas norther may be in part due to waves of cold air descending to take the place of that which friction has caused to ascend the Rocky Mountains.

Diffusion of Jade.—Inferences that extensive intercourse between distant regions prevailed in prehistoric times have been drawn from the general dispersion of jade ornaments in the monuments all over the world, and the paucity of known sources of the mineral. Many possible sources of jade have, however, been discovered within a few years, in view of which the necessity of men anywhere having to go to the ends of the earth for their treasure becomes less apparent. Mr. F. W. Rudler recently mentioned to the Anthropological Institute, as among the later discoveries of jade *in situ*, those of Herr Taube, of Breslau, at Jordans Mühe in Silesia, and at Reichenstein; the rough pebbles that have been found in the valleys of the Sann and the Mur in Styria; Dr. Dawson's account of the occurrence of bowlders partly sawn through on the Fraser River; and the discovery by Lieutenant Stoney of the mineral *in situ* at the Jade Mountains, north of the Konak River, in Alaska.

Medicine in Thibet.—The course of instruction at the Thibetan University of the Guinoie Ozero Monastery is very elaborate and is adjusted for ten years of studentship. It includes the Thibetan and Mongolian languages, religion, drawing, handicrafts, astronomy, astrology, philosophy, and theology. The medical course requires three years. The Thibetan medical authorities, according to the Russian M. Ptitsyn, recognize 101 fundamental diseases; and 429 names of elements of drugs used by them are given. Of the 101 diseases, only two (paralysis and a kind of influence of the planets) are attributed to a mythical origin; and of the 429 drugs, only three (the bones of a dragon, the horns and the skin of the unicorn) have a similar derivation. The remainder of the drugs are chiefly herbs, seeds, fruits, roots, and flowers, and partly mineral matters. All, except quinine, which is bought in Russia, are obtained in Chinese drug-shops. M. Ptitsyn visited one of the drug-shops, and found all drugs kept in order in separate drawers. He has brought samples of 202 drugs to St. Petersburg, and they will be analyzed by the Medical Academy.

NOTES.

The fourth season of the Marine Biological Laboratory at Wood's Holl, Mass., Dr. C. O. Whitman, director, will open for teachers and students, with courses of seven weeks' instruction in zoölogy, botany, and microscopical technique, July 8th. The first week will be devoted to the study of the lobster, the second to annelids, the third to cœlenterates, the fourth to mollusks, the fifth to echinoderms, the sixth to crustaceans, and the seventh to vertebrates (marine). The laboratory for investigators will be open from June 1st to August 20th, furnished with aquaria, glassware, reagents, etc., but not with microscopes and microtomes.

M. de Quatrefages lately reported to the French Academy of Science the discovery, by M. Wanzel, of the skull of a cave bear bearing the marks of a wound that had been received from a stone hatchet. The wound had healed, with the formation of a callus. Two pieces of the hatchet had been broken off by the blow, one of which was left in the wound and had been covered by the callus.

The Pope has written a letter announcing the re-establishment of the donation for the astronomical observatory at the Vatican. He declares that he is solicitous for the progress of science, and places the observatory in the same rank with other papal institutions.

The seventieth birthday of Prof. Helmholtz will occur in August next, and, in anticipation of the event, Profs. Virchow and Du

Bois-Reymond have been constituted a committee to arrange for a suitable celebration of it. A like anniversary will come to Prof. Virchow on the 13th of October, in view of which English and German co-operating committees have been formed. The English committee includes Sir James Paget, Dr. Lauder Brunton, and Dr. Victor Horsley. A medal, bearing Prof. Virchow's likeness, is to be struck, and the rest of the subscriptions are to be given to him personally.

The French Academy of Sciences gave its Lalande prize for last year to Prof. Schiaparelli, of Milan, for his discoveries concerning the rotations of Venus and Mercury; and the Janssen prize to Prof. Young, of Princeton, for his spectroscopic discoveries, especially of the infra-chromospheric layer of the sun which is called by his name.

The fiftieth anniversary of Prof. Arcangelo Scacchi's professorship of Mineralogy in the University of Naples was festally celebrated on the 8th of February. Most of the scientific institutions of Italy and some of other nations were represented, the Geological Society of London and the Mineralogical Society of Great Britain by Dr. Johnston-Lavis. A gold medal, bearing his head and a suitable inscription, was presented to Prof. Scacchi; and a memorial pamphlet containing, with other matters, a biography and a list of his works. He having resigned his professorship, his son, Prof. Eugenio Scacchi, will take his place.

Captain W. de W. Abney has expressed the opinion that the action of light on fugitive dyes must eventually teach us something as to the character of molecules, and add to the methods by which their coarseness may be ascertained.

The mischievous prevalence of locusts in Cyprus is ascribed by Sir Robert Biddulph to the destruction of the forests. By the resultant washing away of the soil the ground became barren, and the locusts at once took possession of it. It is only since the forests were destroyed that this pest has made headway in the manner which has been so notable in modern times. Its great breeding ground is not likely to be ever again covered with forest, and its disappearance will depend on the increase of population and cultivation.

The New York State Engineer has reported to the Niagara Falls Commission that the Horseshoe Fall has receded an average of 104 feet 6 inches since 1742, but at one point 240 feet, while the American Fall has receded 30 feet 6 inches. The crest of the fall has increased in length, from the washing away of the embankment, from 2,260 to 3,010 feet. The area of recession of the American Fall is 32,900 square feet, and that of the Horseshoe Fall 275,400 feet.

From the examination of the paper of Dr. Purdy, of Chicago, and other sources of evidence, the Lancet infers that the most important causes of Bright's disease are improper food, unwholesome occupations, and insanitary dwellings; and from the study of the question it is led to the same conclusion as from the study of phthisis, that "the chief danger of humanity at the present day is that the growth of great cities may lead to the neglect of some of those primitive conditions of health—fresh air, light, exercise, plain food, healthy housing—without which the vigor of the organism can not be long maintained."

Certain resemblances which are sometimes observed between man and wife have been ascribed to the influences which the parties exert upon each other, with increasing effect as they live longer together. Mr. Hermann Fol is of the opinion, however, that more or less striking likenesses often exist from the beginning, and form one of the attractions that bring the parties together. In the photographs of 251 couples, not personally known to him, he noticed resemblances in more than two thirds—in 66·66 per cent of young, and 71·70 per cent of old couples.

Mr. Nevill, Superintendent of the Natal Observatory, South Africa, remarks that the number of thunder-storms has been gradually decreasing in all the larger towns of Natal, but most markedly so in Durban and Maritzburg.

Dr. Oliver, of London, is engaged in an investigation, from a botanical point of view, of the effect of fog upon plants. The examination of specimens of plants affected by fog is in the hands of Prof. D. H. Scott, of the Royal College of Science, South Kensington.

A process for preserving dead bodies by galvanoplasty is described by M. Variot in La Nature. To facilitate the adherence of the metallic deposit, the skin is painted with concentrated solution of nitrate of silver. This is reduced with vapors of white phosphorus dissolved in sulphide of carbon. The body is then treated in the electric bath. The metallic mummy is then incinerated, and after the corpse has disappeared—the gases escaping through openings provided for them—a faithful image or statue remains.

Maintaining that short-sightedness, or myopia, is a product of civilization, M. Motais, of Algiers, cites his ophthalmoscopic experiments with the eyes of tigers, lions, and other wild beasts. Those which are captured after they are six or eight months old are and remain hypermetropic, while those that are captured earlier, or are born in captivity, are myopic.

The Pamban-arivy, or Snake Fall, of Trevancore, India, is a double fall, descending in the first plunge from the cliff edge twelve hundred feet, and can be seen from a distance of forty miles.

OBITUARY NOTES.

Herr Karl Weihrauch, Director of the Meteorological Observatory in Dorpat, Russia, has recently died, at the age of fifty years.

The death was announced, early in the year, of M. Clevaud, Professor of Botany at Bordeaux, and author of the Flora de Gironde, a work of which two parts have appeared, and which "is characterized by its beautiful plates, and by the attempts to place on a scientific basis the genetic relationship of the various species with one another."

Prof. Sophie Kovalevsky, of the University of Stockholm, who died February 10th, was a woman of rare mathematical gifts. Besides an autobiographical sketch, which is described as "one of the finest productions of modern Russian literature," and a fragment of a longer novel, she wrote several able papers in the higher mathematics. She has recorded in her Reminiscences a curious experience of her childhood. In repairing her father's house in the country (Russia), the wall-paper for the nursery was overlooked in ordering from St. Petersburg. For want of anything else, the room was papered with a set of Ostrogradski's lithographed course on higher mathematical analysis. The ten-years-old girl acquired the habit of reading the learned dissertations, and became so familiar with their language that when she began, at sixteen, the study of the differential calculus, her teacher was astonished at the rapidity with which she understood him—"just as if it was a reminiscence of something that you knew before," he said.

Mr. George Wareing Ormerod, of Teignmouth, England, a student of local geology, and author of papers on the salt-beds of Cheshire and the granite of Dartmoor, died in January, eighty years old. He had been a member of the Geological Society of London for fifty-eight years, and continued the compilation of the classified index to its publications, which he began early, till he had reached an advanced age.

Antonio Stoppani, an Italian geologist, died January 1st, at Milan. He conducted a scientific periodical, Il Rosmini, which was in sympathy with the teachings of the philosopher of that name. Of his books, one called Il Bel Paese, or The Beautiful Country, has been published in several editions.

Dr. Felix Liebricht, who died in August last, in his sixtieth year, was an early and successful student of folk lore and comparative mythology. He was a native of Silesia, and spent the greater part of his working life as a professor in the University of Liége. He translated Basile's Pentamerone from the Italian, published a version of the romance of Barlaam and Josaphat, brought out an annotated edition of Gervase of Tilbury's treatise—a sort of encyclopædia of mediæval folk lore—and in 1876 published, under the title of Zur Volkskunde, a selection of his contributions on his special subject to periodical literature.

Charles John Maximovicz, the famous Russian botanist, one of the most distinguished systematic botanists of our time, and the great authority on the plants of Eastern Asia, died in St. Petersburg, February 16th. His scientific career began with a journey in Manchuria, the botanical results of which were published in 1859. He next made large collections in Japan and distributed them among the herbaria of the world. From time to time since 1866 he published critical notes of Manchurian and Japanese plants, and was the author of monographs of the Rhododendrons, the Hydrangeas, and the Buckthorns of Eastern Asia.

General Liagre, of the Belgian Engineers, who died in January last, was well known in the scientific circles of his country. He was attached to the observatory as astronomical aid, and, after the death of Houzeau, as a member of the Directorial Committee. He was a distinguished mathematician.

The death of Mr. John Marshall, President of the British General Medical Council, at the age of seventy-two years, on New Year's day, was followed by that of Mr. Edward Bellamy, Lecturer on Artistic Anatomy at the South Kensington School, January 4th.

Prof. Casey, Fellow of the Royal University of Ireland, an eminent mathematician, died January 3d, in the seventy-first year of his age.

The deaths have been reported of Dr. Karl Weihrauch, Director of the Meteorological Observatory of Dorpat, January 19th, in the fiftieth year of his age; M. Émile Reynier, electrician, January 20th, at the age of thirty-nine years; and Mr. Cosmo Innes Burton, Professor of Chemistry at the English Technical Institute at Shanghai, in the twenty-eighth year of his age.

Dr. Philip Carl, Professor of Physics at the Munich Royal Military College, and editor of the Repertory of Physical Technics and the Journal of Electro-technics, died January 24th.

GEORGE CATLIN.

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THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

VI. THE EVOLUTION OF WOOL SPINNING AND WEAVING.

By S N. DEXTER NORTH.

THE card, and all the machinery preliminary or complementary to its work, are of later development than the inventions for mechanical spinning, which created the necessity for improved methods of carding. The evolution of the spindle is the central point in this development. The spinning of wool with distaff and spindle was the only method known until 1530, when one Jurgens, a baker of Brunswick, invented the one-thread spinning-wheel. A similar instrument was in use in India long anterior to this date, but Europe knew it no earlier. This wheel remained in common use until it was superseded by the spinning-frame. But it was improved a century later by the addition of a second bobbin, the invention of M. Besnière, so that both hands could be used in spinning, and the product nearly doubled at the same cost for labor.

The spinsters were wonderfully clever with this wheel, and performed feats which machinery can not surpass. The transactions of the British Royal Society have immortalized a Norfolk lady, Mary Pingle by name, by recording her achievement of spinning a pound of wool into 84,000 yards (nearly forty-eight miles) of yarn; and Mr. Vickerman vouches for the statement that a Lincolnshire spinster, named Ives, spun a pound of wool into 168,000 yards (95½ miles) on a one-thread wheel. The ordinary spinsters of the period reached 13,000 yards in coarse yarns, and 39,000 yards in the superfine qualities.*

* Charles Vickerman, lecture on The Woolen Thread.

The first attempts at the mechanical spinning of wool were made at about the same time in France and England. We read of a machine experimentally tried at Dolphin Holme in 1784, but success did not come until 1791. In 1780 the French Government gave three thousand livres to an Englishman named Price for the invention of a machine suitable for spinning combed wool.

Fig. 10.—A Wool Spinning-wheel. A, hand-cards; B, bobbin of roving.

Toward the close of the century M. Simonis, of Verviers, built a machine, by the aid of which three persons could spin four hundred hanks of yarn per day. The English succeeded about the same time in spinning combed wool upon one of Arkwright's machines.

The latter half of the eighteenth century witnessed the parturition of automatic textile manufacture. Invention seemed to suddenly awake from a lethargy of thousands of years. One labor-saving machine followed another with astonishing rapidity. The inventions of Kay, Hargreaves, Crompton, Arkwright, Watt, Cartwright, and a host of others, almost contemporaneous in point of time and general adoption, effected a revolution in every branch of textile manufacture such as had not occurred in all previous time, and whose like we can not again expect to witness. No other fifty years in the world's history are comparable with that half-century in their contribution to the world's capacity for the production of the people's clothing. The automatic manufacture of wool received an impetus during these years so prodigious that we are filled with wonder and astonishment as we record the successive steps in the evolution.

Richard Arkwright has been called the father of the modern textile industry. This unique fame has securely and justly fallen to the humble barber who earned fortune, knighthood, and immortality by the keen, practical insight which combined, utilized, and perfected the inventions of others. The genesis of automatic textile machinery was before his advent, however, and he was the adapter rather than the inventor of the spinning-frame. In 1738 John Wyatt, of Birmingham, a man of education and ingenuity, worked out what he termed a "spinning-engine without hands," a machine subsequently improved and patented by Lewis Paul. Probably the two men shared the honor of the invention between them, while Paul obtained subsequent patents for spinning. In the specifications attached to Paul's application for a patent, the art of spinning by means of rollers was described for the first time. The cotton or wool being prepared in a rope or sliver of equal thickness, "one end of the sliver"—so read his specifications—"is put between a pair of rollers, or cylinders, or some such movement, which, being turned round by their motion, draw in the raw mass of wool or cotton to be spun in proportion to the velocity given to the rollers. As the sliver passes regularly through or betwixt these rollers, a succession of other rollers, moving proportionately faster than the first, draw the sliver into any degree of fineness that may be required."

These rollers are the mechanical substitutes for the thumb and finger. The Rev. John Dyer, in his poem on The Fleece, describes in rhyme the operation of the machine, and our readers may contrast this process with the distaff-spinning described by Catullus in the similar meter already quoted:

"A circular machine, of new design,
In conic shape: it draws and spins a thread
Without the tedious toil of needless hands.
A wheel, invisible, beneath the floor,
To ev'ry member of th' harmonious frame
Gives necessary motion. One, intent,
O'erlooks the work; the carded wool, he says,
Is smoothly lapp'd around those cylinders,
Which, gently turning, yield it to yon cirque
Of upright spindles, which, with rapid whirl,
Spin out in long extent, an even twine."

About 1764 James Hargreaves, of Lancaster County, devised an ingenious and practical method of mechanical spinning, without the use of drawing rollers, which he called the spinning jenny, and by which eight yarns or threads could be as easily spun as one. It was eventually perfected to such a degree that a child could keep eighty or one hundred spindles in motion. This machine was used to a limited extent in the wool manufacture, before it was superseded by the throstle of Arkwright and the mule of Crompton.

It is the common understanding that the woolen manufacture owes its development to the application of mechanical ideas first applied to the manipulation of cotton. The two industries have,

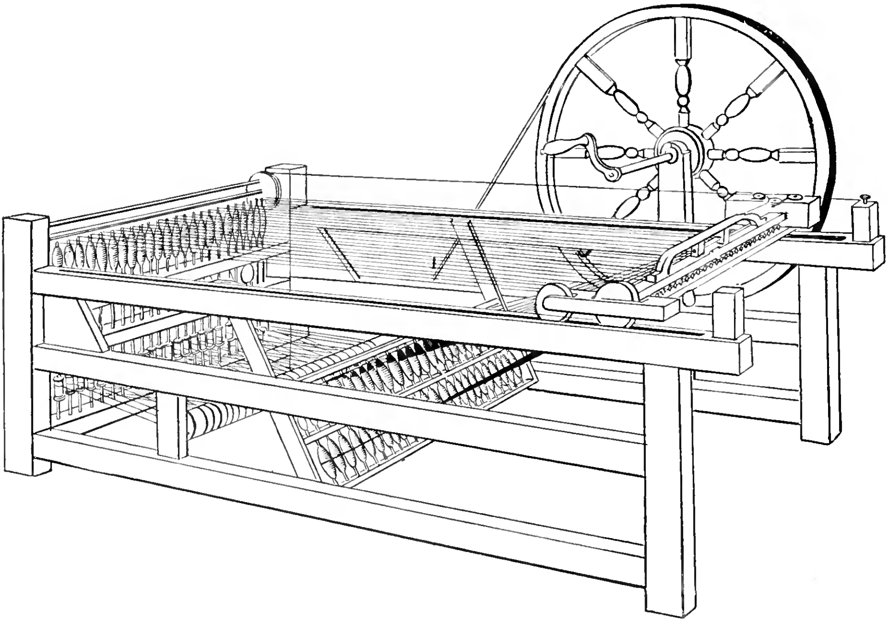


Fig. 11.—Hargreaves's Spinning Jenny, as improved.

indeed, marched forward shoulder to shoulder. They are allies, both in use and in methods of manipulation. Nearly every new idea in the mechanism of one has been turned to good account in the other. Cards for the combing of cotton were first adapted from the woolen manufacture, while on the other hand the woolen manufacture owes a vast debt to men whose discoveries were first applied to cotton. This debt is reciprocal, and it is hard to strike a balance of obligation. It was not until after Arkwright had utilized and developed Paul's machine for "spinning without fingers" that the wool manufacture began to get the full benefit of it. Arkwright's first patent was dated July 3, 1769; it covered the use of successive pairs of rollers drawing the sliver of cotton from one pair of rollers on to another pair running at greater speed, twisting the thread in the mean time by means of wooden fliers, with wire arms for correctly guiding the thread upon the bobbins, and driving the latter by worsted bands. It is worth noting that James Watt obtained his first patent on the steam-engine in this same memorable year 1769. Thus the indispensable auxiliary of manufacturing evolution—the power to drive the machines that were to supersede the hands—had a contemporaneous birth. Long prior to the application of steam-power other agencies than human strength were utilized to drive these primitive machines. We read of asses harnessed to them, and Arkwright drove his first spinning machines with the aid of a bull. The English manufacturers were never able to utilize water-power for driving their machinery to the extent that it was applied in the earlier manufactures of the United States. The streams of New England were long the only motive power of her machinery; and their value to-day, in the various processes of the woolen manufacture, is beyond calculation.

Paul and Wyatt taught the world how to spin a hundred or more threads at one operation; but years elapsed after these early inventions before they came into general use. Paul worked his own machines for many years; but when he died they were broken up and sold, and the world continued to spin on the foot-wheel. The tardy realization of the value of these inventions was due primarily to the opposition of the hand operatives to the introduction of anything in the nature of improved machinery. The guilds were strong, and determined in their refusal to operate or tolerate new devices for dispensing with hand labor. Poor John Kay, after inventing his fly-shuttle, was compelled to close his mill at Leeds by the riotous hostility of the hand-weavers. Learning that he was also engaged in devising machinery for spinning, a mob broke into his house, destroyed everything it contained, and would have killed the inventor himself had not friends smuggled him away in a wool-sheet. We need not be surprised at the blind brutality of these ignorant workingmen. They looked upon the inventor as an enemy, planning to take the bread from their mouths. But what shall we say of the manufacturers who stole the patents of Kay, without recognition of the service his genius had done them? And what shall we say of the Government which permitted this man, in his old age, without recompense for inventions which added untold millions to the wealth of his country, to seek refuge from persecution in France, there to die in abject penury?

It needed a man of the determination of Richard Arkwright to force the world to appreciate the opportunity which these inventions opened before it. In 1775 Arkwright obtained a patent, the specifications of which contained the drawing rollers patented by Lewis Paul in 1738; the roving-can used by Benjamin Buller in 1759; the main cylinder and the finishing cylinder, both used by Thomas Wood in 1774; the crank for working the doffer comb, invented by James Hargreaves in 1772; and a feeder, or cloth for feeding the carding engine, invented by John Lees in 1772.* That Arkwright covered other people's inventions in his patent was officially determined; but of his immense service to the world in teaching it how to utilize the inventions of others, and by their combination and improvement, there can be no doubt. He sought and found capital, keen enough to see the possibilities hidden in crude and isolated inventions. More than twelve thousand pounds had been expended in his mills before any profits were realized. But when profits once began they came fast, and here was made the first of the colossal fortunes which the manipulation of cotton and wool has brought to Great Britain.

Samuel Crompton, the inventor of mule-spinning, had a different experience from Arkwright, although he contributed quite as much to the mechanical evolution of the textile industries. His first mule, invented about 1779, carried forty-eight spindles on a movable carriage, the spindles turning on their axes and centers, while the movable carriage was receding from the rollers, which measured out the roving to a certain length. Two pairs of rollers were used, made of wood and covered with sheepskin, having an axis of iron. One pair revolved at a greater speed than the other, thus producing a draught or elongation of three or four inches to one. The carriage with the spindles could, by the movement of the hand and knee, recede just as the rollers delivered out the elongated thread in a soft state, so that it would allow of a considerable stretch before the thread had to encounter the stretch of winding on the spindle. Crompton thus adopted the system of spinning by rollers, wedded it to the useful jenny of poor Hargreaves, and endowed that union with the spindle-carriage, which was the crowning merit of his invention. Crompton's mule increased the power of a spinner a hundred-fold.

In this machine was first accomplished the automatic mechanical action of the spinner's left arm and forefinger and thumb, which held and elongated the sliver as the spindle was twisting it into yarn. It produced a yarn of much greater fineness and evenness than it had been possible to make by any process previously in use. This invention was the prototype of the mule, thousands of which are at work throughout the world to-day. It got this name from its combination of Paul's and Hargreaves's inventions.

The Crompton machine was correct in principle, but a rude piece of workmanship, dependent in all its original movements upon manual labor. Water was first applied to it as a motive

* Bennet Woodcroft.

power in 1790, by William Kelly, of Scotland. It was not until 1825 that the self-acting mule was evolved by Richard Roberts. His second patent, dated in 1832, made the self-acting mule applicable to the wool manufacture. But its use continued to be confined, for years afterward, almost wholly to the cotton manufacture. In almost all the American woolen-mills, down to the close of the civil war, the spinning continued to be done on the hand-jack, which is still found in many of them. The introduction of the automatic mule, which became general about 1870, has enormously facilitated the manufacture. It is stated by careful manufacturers that the substitution of the automatic mule, with the other improved machinery which has come during the same period, has resulted in a gain of fully thirty per cent. in production in twenty years. The economical gain, in the saving of help, is even more striking. Experts have calculated the difference between hand-jacks and mules in the cost of manufacture, as follows: Forty-eight cents for one hundred run yarn, with the jack; twenty cents for the same yarn, with the mule, or less than one half.

The hand-jack usually carries 240 spindles, revolving from 4,000 to 4,500 times a minute. Mules carry 300 or more spindles. In the organization of a woolen-mill one set of cards, which requires about twenty-six horse-power to run, will keep from 400 to 500 spindles in motion, although this relationship varies greatly, according to the class of goods manufactured, the age of the machinery, and the capacity of superintendents. American woolen-mills run, in their equipment, all the way from one to seventy sets of cards, and from 240 to 25,000 spindles.

In the woolen manufacture proper, as now conducted, there is but one process after that of carding and condensing to the perfect yarn, ready for the loom. The condensed sliver which has come from the cards is in fact a sort of yarn, which requires only twist and elongation to impart strength, firmness, solidity, and to reduce it to the proper size. The mule has two distinct motions which effect elongation and twist simultaneously. The carriage travels backward and forward, and carries the spindles which hold the bobbins on which the sliver has been wound, while in the frame are fixed other bobbins, called condenser bobbins, to receive the yarn. The machine in operation gives out from small rollers, fixed in the frame, a certain amount of the sliver, simultaneously with the imparting of a degree of twist; then the rollers cease to revolve, while the carriage continues to recede, drawing out the sliver to the necessary length, while in the mean time the spindles, revolving with an increased velocity, furnish what is called the finishing twist. The rollers limit the length of sliver to be operated upon, the carriage draws it, and the spindles impart the twist. This is a very general description of one of the most complicated and beautiful processes in the whole manufacture, performed upon a machine which the operatives in some parts of Europe call "the iron man," in allusion to its deft action.

The mule is the machine now universally used in the manufacture of woolen yarn. But an entirely different method of

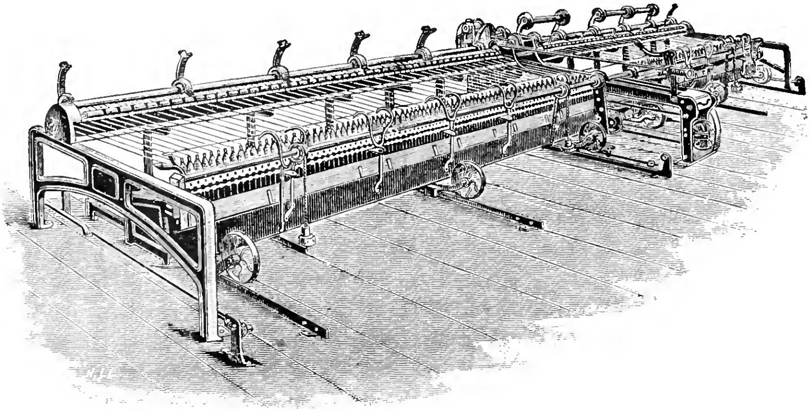


Fig. 12.—A Woolen Mule.

spinning is also applied in the woolen manufacture, or in that branch of it known as the worsted manufacture, quite distinct in several of its preliminary details, and quite as important in the modern development of the industry.

These two distinct processes of manufacture which have grown up in the treatment of wool, have practically made two industries out of one. They are alike, in that they utilize the same raw material, and do not essentially differ until the process of carding is completed. This diversion of the industry is traced to the immigration of the Flemings, which occurred during the reign of Henry I, although historians have attempted to antedate the worsted manufacture even to the Saxon period. The worsted manufacture originated at Worsted, a town in Norfolk, where one of the early Flemish colonies existed whose people employed a method of their own in treating the wool, which produced a woolen stuff of a peculiar quality, to which the name of worsted was given.* There is no earlier record of its existence than the time of Edward II (1315), when a complaint was made to Parliament that the clothiers of Norwich who manufactured worsted

* It is curious to observe how names have been inherited in the wool manufacture. Worsted is so called from the town where this particular method of manufacture originated. "Hank" is derived from the name Hankemus de Brabant, a Flemish spinner who settled in York; and "blanket" from the name of three brothers Blanket, also Flemish, who settled, at Bristol, among the immigrants tempted to England by the liberal inducements of Edward III.

were making pieces only twenty-five yards long and selling them as thirty (the regulation length).

Instead of simply carding the wool, the Flemish combed it. The hand-comber employed two combs—one as a "pad" comb, which was fixed to a post by an iron rod. The raw material, after being properly prepared, washed, oiled, and separated into convenient handfuls, was lashed into the comb upon the pad. Thus loaded with wool, the comb was placed in a stove adapted to the purpose and called the comb-pot, and when properly heated, one comb upon the post, the other held in the hand, the process of combing began, each comb becoming a working comb alternately, the teeth of one passing through the tuft of wool upon the other, until the fibers became perfectly smooth, straight, and free of short wool, or "noil," which was left imbedded in the comb-heads—the residue being called the "top."* The illustration shows how the hand-comb differed from the card used in the preparation of the wool for the woolen yarn.

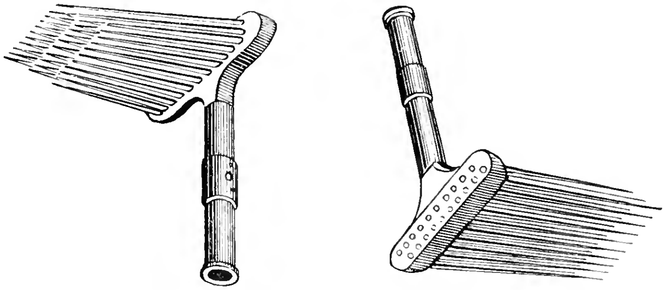


Fig. 13.—A Pair of Hand-combs.

The material when thus combed differed from the same material carded, in that the combed wool contained only the long fibers, which lay parallel, the short fibers or noil having been altogether rejected or combed out. The carding eliminates no noil. Long and short fibers go together to the spindle. Thus it happens that a woolen yarn is soft and fluffy, while a worsted yarn is hard and firm, possessing a much greater tensile strength. In the woolen yarn the fibers are tangled and crossed, and drawing is avoided as much as possible in preparing the raw material for spinning, so as to leave the natural curvature of the fibers undisturbed and afford the greatest freedom of action to the felting quality of the wool. In worsted yarns the object is to obliterate the felting

* The origin of the word "top" is attributed to the fact that the product of the hand-comber was wound by him into a ball which took on a shape quite like that of a boy's top —large above, and tapering nearly to a point. The origin of the word "noil" is not as satisfactorily explained. Vickerman says that the term is from the Latin, and means "knotty," or "not do"; but this is at least doubtful.

quality and to secure elongation and parallel arrangement of the fibers."

In the early days of the manufacture the best results were only attainable in worsted yarns from long-fibered fleece. The English wools are commonly called combing-wools for this reason, and it was the possession of this fleece of an unrivaled quality which made England the birthplace of the worsted manufacture, and has kept it at the front in this process.

One of the results of improved machinery has been to remove any distinction between woolens and worsteds based upon the difference between the wools employed in the two processes. Short wool of merino blood can now be combed as successfully as the longer staple. The processes of treatment, however, continue to differ radically. This difference, as already seen, is primarily created by the introduction of the combing machine, an instrument unknown to the wool manufacture proper.

Short-stapled wool is carded before going to the comb; but the long wools, to avoid the breaking of the fibers which would result from carding, are prepared for combing by screw gill-boxes, so constructed as to open, separate, and straighten the fibers. Five or six slivers obtained from the first gill-box may be run into one by the use of a second gilling machine, so intermingling them that the deficiencies of one sliver are supplied by its neighbor. The half-dozen slivers are thus drawn into one smaller than any of those of which it is composed. This operation is continued through other gill-boxes when fine counts of yarn are desired, until the fibers have become thoroughly separated and parallel, to facilitate the work of the combing machine.

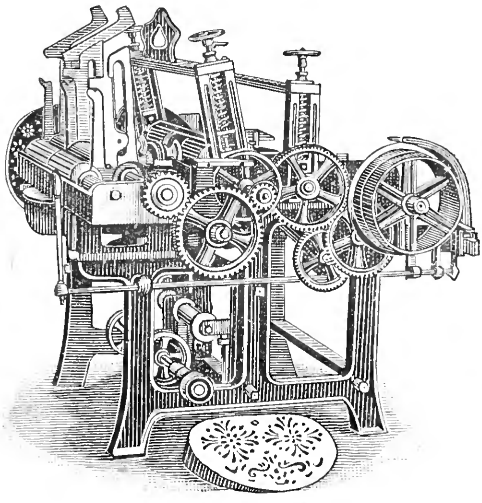


Fig. 14.—A Gilling Machine.

This machine is the mechanical wonder of the wool industry. It performs with automatic precision a series of complicated movements long deemed to be only capable of accomplishment by hands guided by human intelligence. For years after the idea of the machine took germ, it was the hope and the despair of many inventors in England and on the Continent. The hand-worker remained in exclusive control of the delicate operation until 1830.

Human intelligence required for the successful performance of combing expertness and experience in high combination. Woolcombers came to be a class by themselves in England—a class magnifying its own importance and skill—quite the aristocracy of the manufacture. For years after the experiments of the inventors were well under way, and even after machines were in

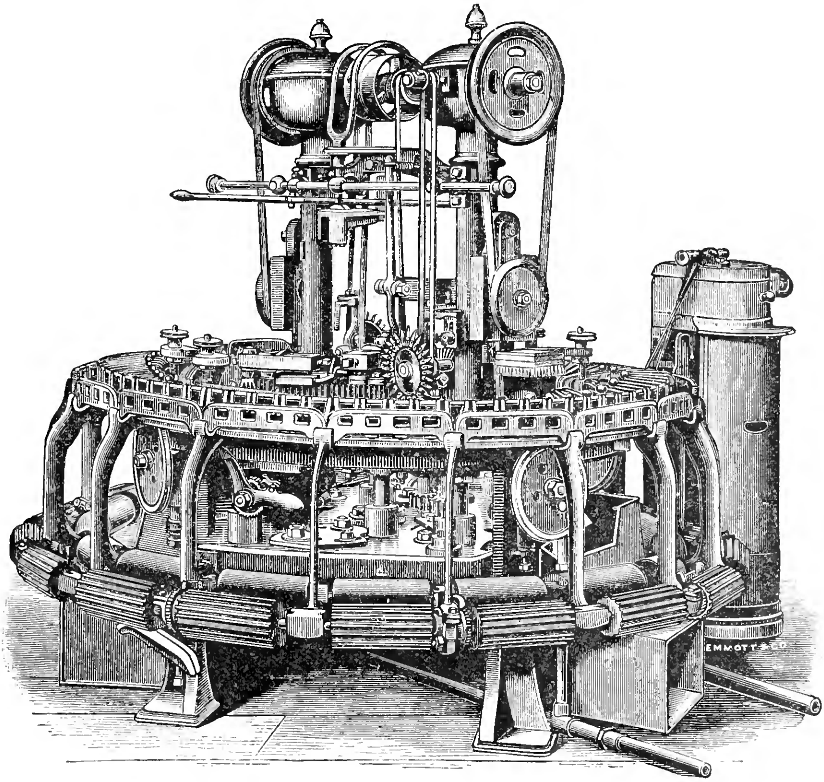


Fig. 15.—A Noble Comb.

actual use, the hand-combers remained confident that no automatic machine could supersede their boasted expertness of hand. Failure after failure seemed to warrant their confidence. The combing machine is one in which the power of the capitalist, no less than the genius of the inventor, has been exemplified. It cost more to complete, and has yielded more in the way of profit to its inventors, than any other machine of the century. To Dr. Edmund Cartwright, the inventor of the power-loom, belongs the honor of creating the germ of the subsequent machines. His first machine, patented in 1789, consisted of a cylinder, armed with rows of teeth, revolving in such a manner that its teeth would catch and clear out the wool contained in the teeth of a fixed and upright comb. His second machine, patented in 1790, superseded this imperfect movement by the contrivance of a circular horizontal comb-table. The machine attracted great attention, and the wool-combers, of whom there were 50,000 in England, immediately petitioned Parliament for its suppression. A bill for that purpose was actually introduced in the Commons. As years passed with-

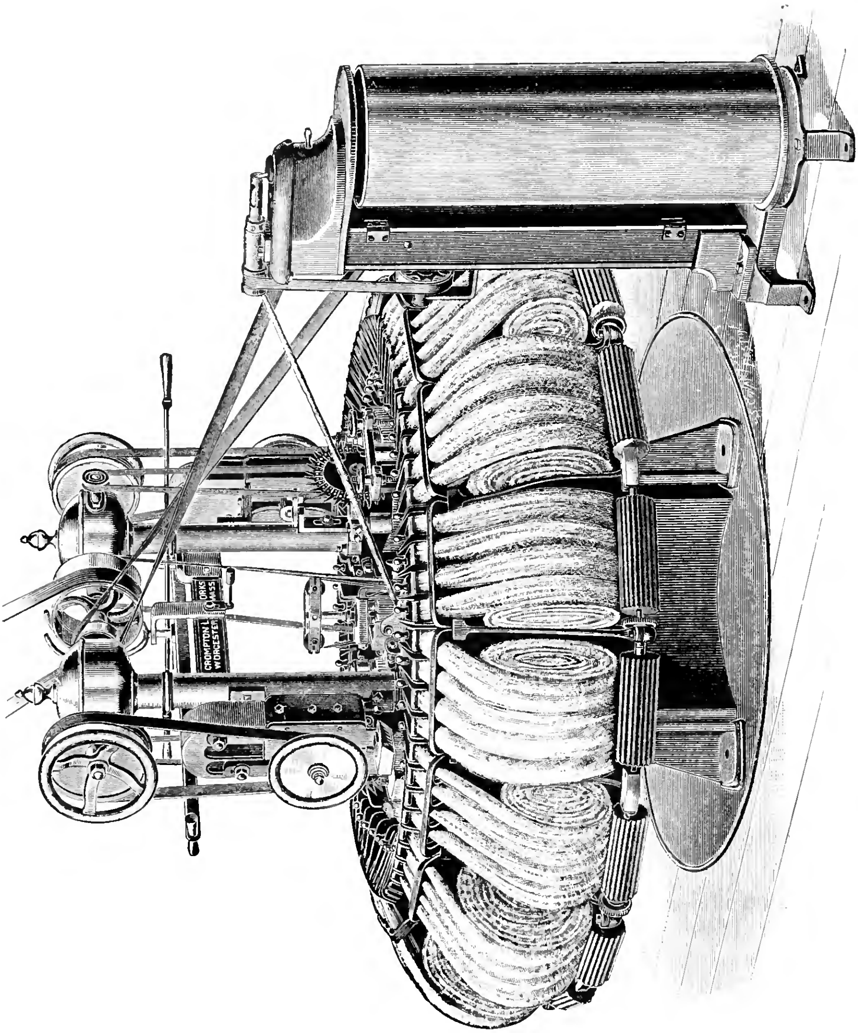


Fig. 16.—An American Combing Machine.

out the successful application of the machine, they grew confident, and their annual celebrations of the anniversary of St. Blaize—the patron saint of the wool-comber—became largely demonstrations of defiance to the inventors.

Controversy will always exist as to who first evolved a successful combing machine. The names of George Edmund Donisthorpe, Samuel Cunliffe Lister, James Noble, and Isaac Holden are equally associated with the evolution of the machine in England; while that of Josue Heilmann, an Alsatian, who undoubtedly worked out a combing machine on independent lines, is immortalized by his invention, which was patented in France in 1845, and in England in 1846.

The various inventors named created three machines, working upon different principles, all of which are now in use, and each of which has points of superiority in different kinds of work. They are known as the Lister, the Noble, and the square-motion combs; the French machine, founded upon Heilmann's invention, being a modification of the Lister. In 1843 Mr. Lister succeeded in combing the first fine wool (Botany) ever combed by machinery. After that the use of the machines speedily became general. The Noble comb is in the most common use, perhaps, being found superior for combing the short-stapled wools now largely utilized in the worsted manufacture. The Lister machine is preferred for the long-stapled wools. The picture of the Noble comb conveys a good impression of its general appearance. An intelligible description of its complicated and delicate parts is out of place in a paper of this description. Only when seen in operation can one truly appreciate what a wonderful achievement of the human mind is the combing machine.

From the comb, the wool intended for worsted yarn, now in the form known as "tops," goes first to a back-washing machine, to eliminate any remaining dirt, and is again gilled. The introduction of the gill-box, or drawing machine, now effects another distinction between the worsted and the woolen yarn. It is the beginning of a process of drawing, which continues through many subsequent machines. The worsted yarn is the result of a series of combinations or doublings accompanied by drawing or stretching. The drawing machine combines and reduces the thick sliver, or a number of them, down to a size so small that it can be spun into a thread without an excessive draft, and at the same time levels it so that the thread will be of uniform thickness. The sliver is put through six or more machines, each of which combines and draws half a dozen larger slivers—more or less according to the size of the yarn to be spun. Thus, in a Botany wool, with nine operations, the number of slivers ordinarily combined are 8, 6, 5, 5, 5, 4, 3, 2, 2, which are equal to the enormous number of 288,000 doublings. There have been at least two doubling operations between the comb and the top, of say ten and six slivers in each case, so that the total doublings from the comb to the spindle amount to 17,280,000. By this process of continued doubling and drawing, it becomes an easy matter to spin worsted yarns of extreme fineness, running in their counts all the way up to 80s, 90s, and even higher, the French particularly excelling in the manufacture of very fine counts, to which their system of worsted mule-spinning seems to be especially adapted. The finer yarns spun in America will usually average about 40s, which involves a length of more than 20,000 yards to a pound of yarn.

From the drawing machines, the material next advances to the roving frame, the last operation through which the sliver—called "slubbing" at this stage of manipulation—must pass before it is ready for spinning. Roving may be described as a combination of drawing and twisting, with an excess of drawing; while worsted spinning is a combination of the same processes, with an excess of twisting.

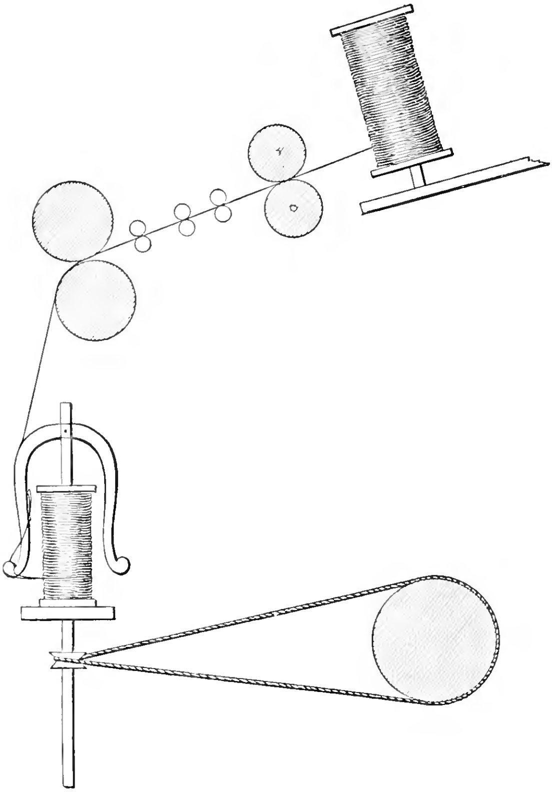


Fig. 17.—Flier-spindle.

The spinning-frame, originally used in the worsted manufacture, is very different from the mule, the roving having been subjected, as we have seen, to processes not required in dealing with the condensed sliver. In the worsted spinning-frame, or throstle, the rollers are so arranged as to draw out the roving before any twist is imparted. There are three distinct types of worsted spinning-frames in common use, known as the flier, cap, and ring. The French utilize a fourth method, involving a different preparation of the roving, which is simply the principle of mule-spinning, already described. A flier-spindle is shown in the illustration.* It is most commonly used for the

* It is quite clear that the flier, which is fitted around modern spindles for twisting the yarn before it is wound on the bobbin, was known to Leonardo da Vinci, and probably invented by him. Among his mechanical drawings is one which shows a spindle, with flier and bobbin, with a device for moving the bobbin up and down on the spindle so as to effect

lower counts of yarns. The flier-spindle has a rotary motion. In cap-spinning (see illustration) the spindle and the cap are the stationary parts. A tube or shell, which receives the bobbin, is placed on the spindle, and its motion distributes the yarn upon the spindle. Cap-spinning is chiefly utilized in the finer counts of yarn, as there is no limit to the speed at which the bobbins may be made to revolve. In ring-spinning, which is more common in the cotton manufacture, the spindles revolve, and the bobbins are so attached as to revolve with them, thus imparting their own twist. The ring-frame is more largely used in the worsted-yarn manufacture for doubling, or making twofold yarns, than for spinning.

Fig. 18.—Cap-spindle.

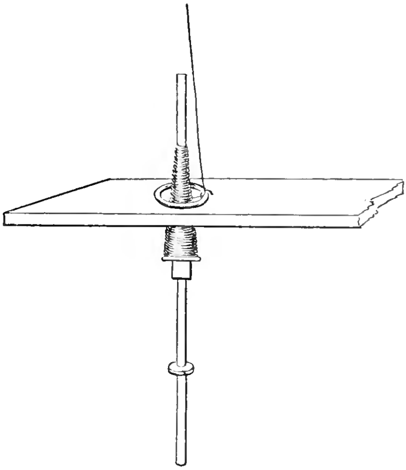


Fig. 19.—Ring-spindle.

It may now be easier for the reader to fully comprehend the difference between a woolen and a worsted thread—made from the same wool in many instances, but so differently treated in manipulation that they seem almost as fundamentally unlike as a woolen and a cotton thread. Worsted has received a treatment similar in many respects to that by which a cotton thread is made. We have seen that the worsted manufacture is a series of processes continuously following each other, and that the woolen manufacture is a compound process intermittently carried on. The woolen sliver, after leaving the carding machine, is wound at once upon bobbins attached to the mule. In this machine the spindles have a compound motion, simultaneously in progress, whereby the sliver is drawn and wound. This operation completes the woolen thread. This yarn requires very different treatment, both in the weave and the finish, from the worsted yarn. The latter is distinguished by a compact weave, ready at

an even distribution of the yarn. But the use of the flier was not known in England before the end of the seventeenth century. In a pamphlet printed in 1681, by Thomas Firmin, there is an illustration of an improved wheel, with two spindles, provided with fliers, having on them hooks or pins for directing the yarn on different parts of the bobbin.—*Encyclopædia Britannica.*

once for the finishing. The woolen fabric comes from the loom loose, open, rough, and must be thoroughly milled or fulled before it is finished.

The woolen cloth—spun on the mule, and milled—was, until a few years back, the only wool fabric made for men's wear. There are innumerable varieties of it, including broadcloths, doeskins, twills, flannels, tricots, beavers, cassimeres, cheviots, meltons—trade-names which stand for certain standard fabrics, with little regard for their etymological significance. Until the year 1840 the wool manufacture of the United States was exclusively confined to the woolen form. In that year the first delaines made in this country were manufactured at a mill in Ballardvale, Mass. All the wool was combed by hand, and the printing of the goods was at first also by hand. The success of this experiment started others in the field, and by 1855 several of the largest establishments in the country were engaged in the manufacture of ladies' worsted dress goods.

The use of the worsted process in garments for men's wear is as recent as the year 1866. It appears to have originated in England, where Josiah Lodge, of Huddlesfield, claims to have been the first to utilize the process in the manufacture of men's trouserings and suitings. The innovation was quickly adopted in France, in Germany, and in the United States, and these worsted suitings are so popular and so serviceable that the manufacture of wool goods may almost be said to have been revolutionized in the interval. There are to-day as many persons and looms employed in the worsted manufacture in England as in the woolen manufacture, and the substitution of worsted for woolen machinery has been going on at a rapid rate. The largest wool manufacturing establishment in the world, that of Isaac Holden & Sons, at Bradford, England, contains three hundred sets of cards and three hundred combing machines, and is exclusively employed in the manufacture of "tops" for the worsted spinners. In this country our largest mills are engaged in spinning worsted yarns and weaving worsted cloths. In their equipment they run from two or three combs up to fifty or sixty, and from ten thousand to fifty thousand spindles. It is impossible to state a relationship between combs and spindles, owing to the great variety of the yarns and fabrics made from worsted. Although no radical improvements have recently been made in the comb, the efficiency has been increased about thirty per cent in the last twenty years. In 1870 the product of a comb was from four hundred to four hundred and fifty pounds a day. The same labor will now produce from seven hundred to eight hundred pounds, yielding a better quality of product.

The Evolution of Weaving.

The earlier improvements in spinning machinery which have been described, preceded, in point of time, the development of the loom, and thus made more conspicuous the primitive methods of weaving that continued in vogue, and became a stimulus to inventors in this field. Arkwright's machinery was even regarded as an evil, for a time, on the theory that it enabled England to spin more yarn than her weavers could fabricate, and the surplus, exported to the Continent, could there be woven into cloth so cheaply as to seriously injure English trade.

The strict chronological order of the initiative steps in the development of woolen machinery would have headed the list of the noble army of inventors with the name of John Kay. Kay had the management of a woolen factory at Colchester, England, belonging to his father. Having a sort of universal genius for mechanical invention, he introduced various improvements in dressing, batting, and carding machinery, as well as in the Dutch drawboy and inkle looms, that had been brought from abroad by his father. He also invented an improvement in reeds for looms, by making the dents of their polished blades of metal, instead of cane (the only materials used up to that time), by which they were not only rendered more durable, but adapted to the weaving of fabrics of a finer, stronger, and more even texture than cane reeds could produce. Kay secured patents for several of these improvements, which were universally adopted. But his crowning invention was the first fly-shuttle known to man, patented May 26, 1733. Hitherto the shuttle had been thrown back and forth between the warp threads, being thrown by one hand and caught by the other alternately, while each weft thread was driven home by the "layer," propelled by the hand which had just cast the shuttle. In broadcloths, the process differed in this, that a weaver stood upon either side of the work, and the shuttle was thrown alternately from one to the other. Thus for more than five thousand years, by millions of skilled workmen, one generation following in the exact footsteps of another, had the clothing of the people been woven, with little attempt to expedite or to simplify the process. Thus had been fabricated the mummy-cloth of Egypt, the "woolen wind" or fibrous muslins of the Indias, the rich tapestries of the Greeks and Romans, and every other fabric of every character and age.

John Kay's invention consisted of a race-board fixed to the "layer" under the warp, with a shuttle-box at each end, a spindle and picker in each box, and a cord passing from each picker to a short lever held in the weaver's right hand. These improvements did not dispense with the weaver's hands and feet in forming the cloth, but they permitted one hand to be used exclusively in throwing the shuttle, while the other was solely occupied in driving home the weft. The comparative speed of fabrication, by reason of this invention, won for it the name of "fly-shuttle"; and in truth it is likely that no division of labor between the two hands of one operative ever produced results equal to those which this invention secured.

At once, upon its general adoption, the average production of a loom was more than doubled, and the cloth was of a better quality than formerly. The same shuttle arrangement, with hardly any change, appears in the looms upon which our grandmothers wove their homespun, and they may still occasionally be seen in the old farm-houses of the United States.

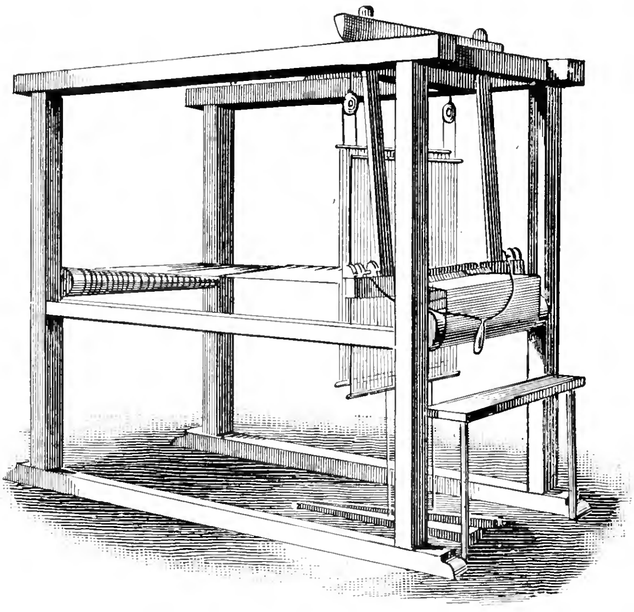


Fig. 20.—Common Fly-shuttle Loom.

As early as 1678 a French naval officer, M. de Gennes, conceived the idea of a power-loom, and communicated his plan to the French Academy. He described, prophetically, the advantages its utilization would effect in economy, in uniformity of product, and in increase of production—precisely as we have since realized them. More than a century elapsed before his ideas were successfully utilized. Numerous attempts were made, but through one defect or another they failed of adoption.

A studious clergyman, addicted more to poetry than to trade, led the way in the solution of this problem. His name was Edmund Cartwright, already alluded to in connection with the combing machine. He had never set foot inside a cotton or woolen mill at the time when he undertook to revolutionize their entire methods. A strange-looking and clumsy machine Cartwright's first power-loom was, according to his own description. "The warp," he wrote to a friend, "was placed perpendicularly, the reed fell with a force of at least half a hundred-weight, and the springs which threw the shuttle were strong enough to have thrown a Congreve rocket. It required the strength of two powerful men to work the machine at a slow rate, and only for a short time; but I succeeded in weaving by its aid a piece of coarse cloth like sail cloth. Conceiving, in my great simplicity, that I had accomplished all that was required, I then secured what I thought was a most valuable property, by a patent, on April 4, 1785. This being done, I then condescended to see how other people wove; and you will guess my astonishment when I compared their easy mode of operation with mine. Availing myself, however, of what I then saw, I made a loom in its general principles nearly as they are now made." The theologian, having learned what the weavers could tell him, taught them more than they had been able to teach themselves in a thousand years.

The principle and the working of the hand-loom and the power-loom of Dr. Cartwright were the same, and they continue to be the same throughout all the modifications of the perfected loom. Their three fundamental motions are, first, the "shedding," or dividing of the warp threads by means of harnesses, to permit the passage of the weft threads between them; second, the "picking" or shooting of the weft; and, third, the "battening" or beating home of the weft. In the first power-loom, Dr. Cartwright combined, with the frame, the beam, the heddles, and the harnesses of the hand-loom, mechanical substitutes for the weavers' hands and feet. They were tappets and treadles, for operating on the warp; apparatus for throwing the shuttle, driving home the weft, letting off the warp, taking up the cloth, stopping the loom on the breaking of a thread, and self-acting temples. The problem of weaving once solved, however crudely, improvements upon Dr. Cartwright's loom followed naturally. Dr. Jeffray, a Paisley physician, soon improved the Cartwright loom by introducing a device to prevent the breaking of the weft: and it was again improved by one Miller, of Dumbartonshire, who substituted for the spring, in throwing the shuttle, the direct action of the motive power. The splendid machines of to-day, doing their beautiful work so smoothly, so perfectly, so rapidly, have grown gradually, one improvement following another, out of the clumsy Cartwright machine so quaintly described above. It is a source of pride to American manufacturers that in this department also the contributions of American inventors have vastly advanced the industry and have been recognized throughout the manufacturing world. Not only did two distinguished Americans, Francis C. Lowell and Patrick T. Jackson, practically reinvent the power-loom, in 1813, as applied to cotton goods, but another, an adopted citizen, William Crompton, first adapted the power-loom to the weaving of fancy woolen fabrics, and to-day the two principal

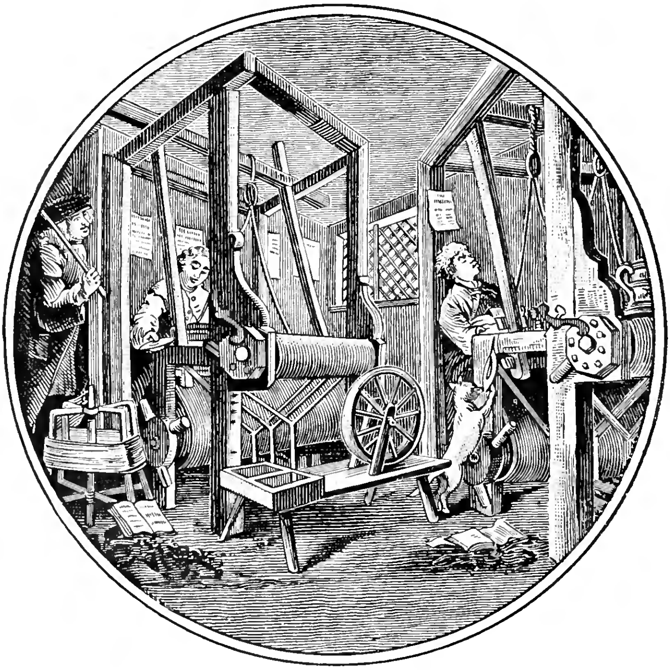


Fig. 21.—Hand-loom of 1750. (From Hogarth's Two Apprentices.)

makes of American looms, the Crompton and the Knowles, are generally recognized as superior to any foreign patterns and are largely used in foreign mills.* Crompton's fancy power-loom was applied to woolen fabrics in 1840. "Not a yard of fancy woolen fabrics had ever been woven by a power-loom in any country," wrote Samuel Lawrence, "until it was done by William Crompton at the Middlesex Mills, in Lowell, in 1840." It was affirmed before a congressional committee in 1878 that "upon a Crompton loom, or looms based upon it, are woven every yard of fancy cloth in the world." The importance of this contribution to the wool manufacture can only be appreciated in connection with the fact that three quarters of all the woolen cloths now worn are woven upon fancy looms. Up to that time it had been

* Over eight thousand of the Knowles open-shed fancy looms are now in operation in England.

deemed impossible to successfully weave the finer worsted fabrics except by hand.

There is no machine of Crompton's first build known to be extant, nor even a picture of one. In 1855 it was greatly improved, and its capacity increased from eighty to ninety picks per minute. The illustration shows one of the narrow looms of the 1855 pattern, with its working parts well brought out. In 1857 the Crompton establishment perfected the pioneer broad loom, of which great numbers were made during the succeeding ten years. They were made ninety-two inches wide in the reed space, and attained a speed of eighty-five picks a minute with twenty-four harnesses, thus practically doubling the productive capacity of the operative, who could attend a broad loom as easily as a narrow loom. This machine was therefore an enormous stride in advance; none that has since been made can equal it.

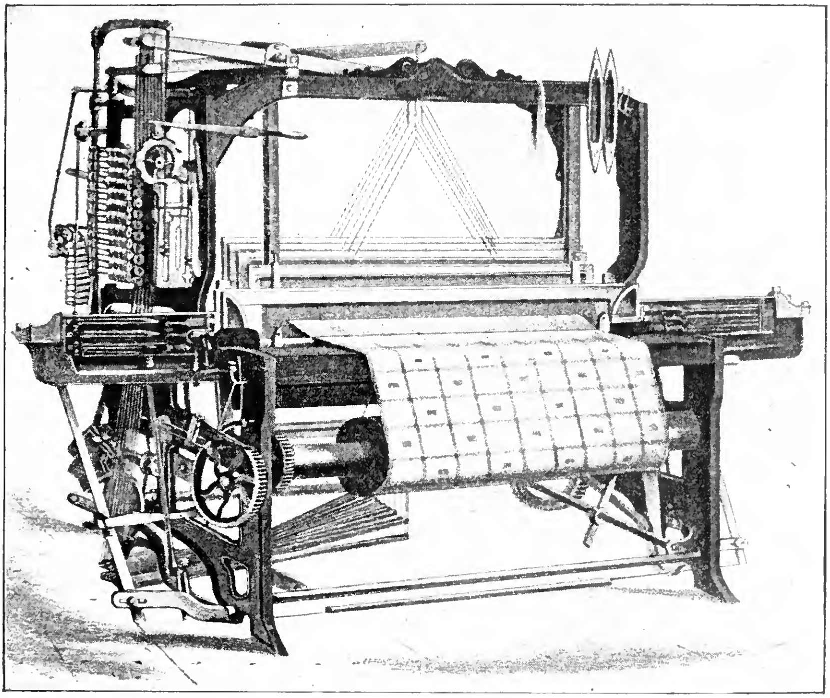


Fig. 22.—The Crompton Fancy Narrow Loom of 1855.

Mechanical weaving has now reached a perfection that the hand-loom can not attain. There is greater regularity in the product, less waste of material, and great saving of labor—one weaver in the lighter fabrics easily attending to two or three looms. The power loom is worked without muscular effort, dexterity in the repairing of broken yarns being the chief requirement of the operatives. Consequently, women have almost universally superseded men in its operation.

I shall attempt no description of the power-loom, or of its complicated motions. The illustrations represent the most recent patterns of American broad looms for heavy worsteds, of twenty-five or thirty-six harness capacity, upon which can be woven every variety of fabrics, from the simplest to the most intricate. These looms can be arranged for the Jacquard attachment.

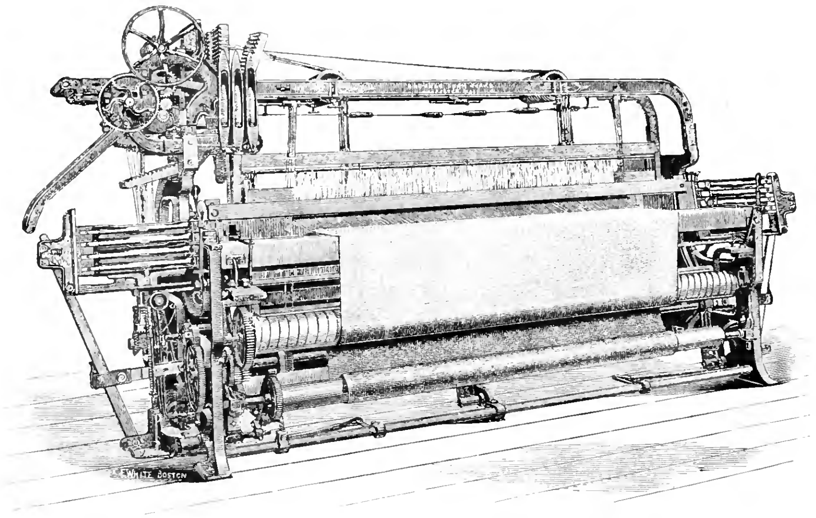


Fig. 23.—Knowles's Open-shed Fancy Loom.

Remarkable success has attended the efforts to increase the speed of the power-loom. They are built to vary in speed from fifty-four to three hundred picks a minute, according to the fabric upon which they are employed. One hundred and fifteen picks a minute, for each one of which the shuttle travels one hundred and fifteen inches, is now accomplished in the weaving of fancy worsteds. This is not a single or simple motion, but a series, each dependent on the other. The power-loom, at one and the same time, forms the shed in the warp threads, as called for by the pattern or design, and, through the agency of few or many harnesses, propels the shuttles in consecutive order across the piece, beats the picks of weft into close compact, and winds the woven cloth on the piece-beam. Should the wet yarn break or run off the bobbin, or should the shuttles fail to reach home, the loom automatically stops itself. What more can human ingenuity do for the power-loom?

However improved, the principle of weaving is that utilized in the primitive hand-looms. No more complicated pattern or weave can now be made than the ancients achieved on their hand-looms.

Homer describes a product of Creusa's shuttle, in which appeared a gorgon and dragons. The damasks and tapestries of the ancients were as elaborate in figure-work, woven into the warp and woof, and more beautiful in coloring, than modern machinery has ever achieved. The famous Gobelin tapestries, with their elaborate allegorical scenes, present a development of the art impossible

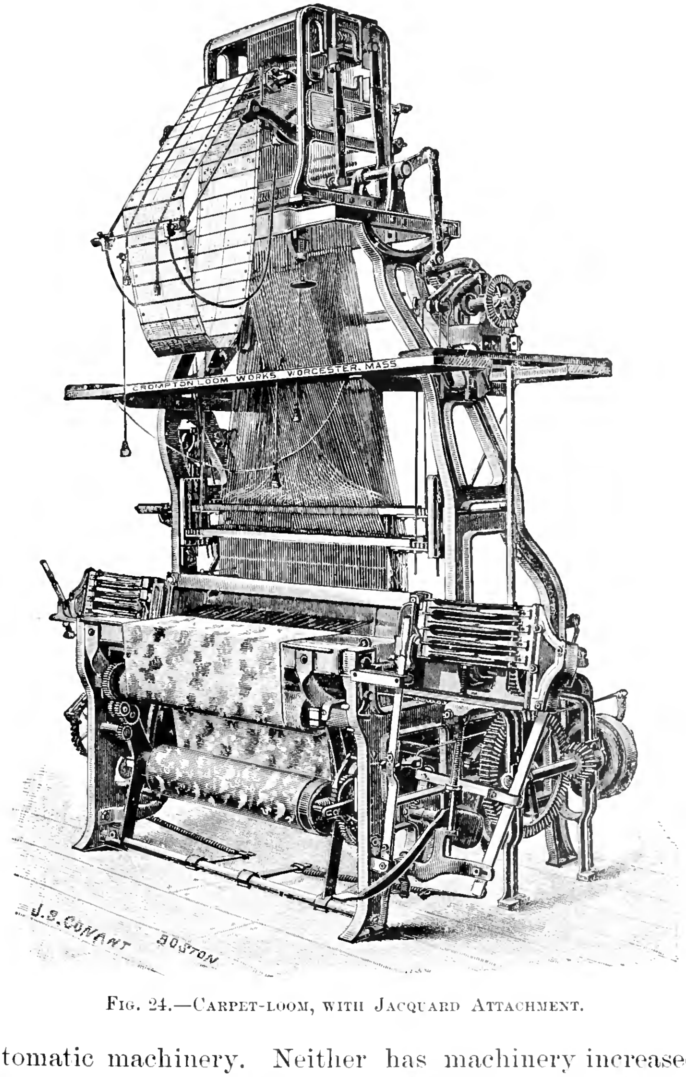


Fig. 24.—Carpet-loom, with Jacquard Attachment.

to automatic machinery. Neither has machinery increased the number or variety of the weaves in common use. But a single invention, that of Joseph Marie Jacquard, and known by his name, has made possible in power weaving the making of figured patterns without limit of variation, thus robbing the hand-loom of one of its last points of superiority. Jacquard perfected his invention in 1800, and its use has gradually become general in figured goods. It is regarded as the greatest invention in the art of weaving, next to the power-loom itself, and was only eclipsed by that of our own inventor, Erastus B. Bigelow, who made the Jacquard loom automatic. A report of the patent commissioner has declared that "Mr. Bigelow's invention presents a machine which is admitted to be unsurpassed by anything which the mechanical genius of man has ever devised." Mr. Bigelow's invention was patented in 1838, but not perfected for Brussels carpets until ten years later. It revolutionized that industry at once. The cost of weaving Brussels carpets had hitherto been about thirty cents a yard, and the product of the hand-loom did not exceed four yards a day. The Bigelow invention made it easy for a single female weaver to weave from twenty-five to thirty yards of carpet a day, at a cost for labor of about four cents a yard. With the expiration of Mr. Bigelow's patents a most extraordinary impetus was at once given to the carpet manufacture in the United States, where to-day more carpets are made and used than in any other country.

The power-loom, as to-day constructed and used, is unquestionably one of the most perfect, as it is one of the most complicated, of human inventions. The range of textiles, hitherto made only on hand-looms, is becoming, on account of the constant development of the power-loom, more limited every year. It is only in the production of fabrics in the weaving of which continual and elaborate changes have to be made in the colored weft threads that the hand-loom is still used—excluding, of course, its permanent use as a pattern-loom.

The development of the loom has been accompanied by many inventions which simplify and expedite loom-mounting, which includes all the processes through which the warp yarns must pass between the spinning-frame and the loom. Filling is wound directly into a cop for the shuttle, and placed therein, ready for the weaving. The processes to which warp yarns are subject are known as warping, sizing, beaming, healding, and sleying. They determine the character and variation of the weave; and, in a sense, the art of cloth manufacture, as distinguished from its mechanics, may be said to center in them, and in the designing-room, from which they are controlled. We have left ourselves no space in which to even allude to the various interesting and ingenious machines now utilized in the preparation of the warp for the loom. Necessarily this is the point in the manufacture of fancy goods where automatic machinery can not be wholly applied. In connection with the action of the harnesses in the loom, all the variations of the weave are determined by the designer, whose plans for the distribution and shedding of the threads must be carried out by hand.

The study of the weaves and of the possibilities of variation in fabrics, arising from the different methods of inserting the weft threads into those of the warp, from the use of different colored threads, both for warp and weft, and by the use of different materials, is perhaps the most fascinating branch of the whole

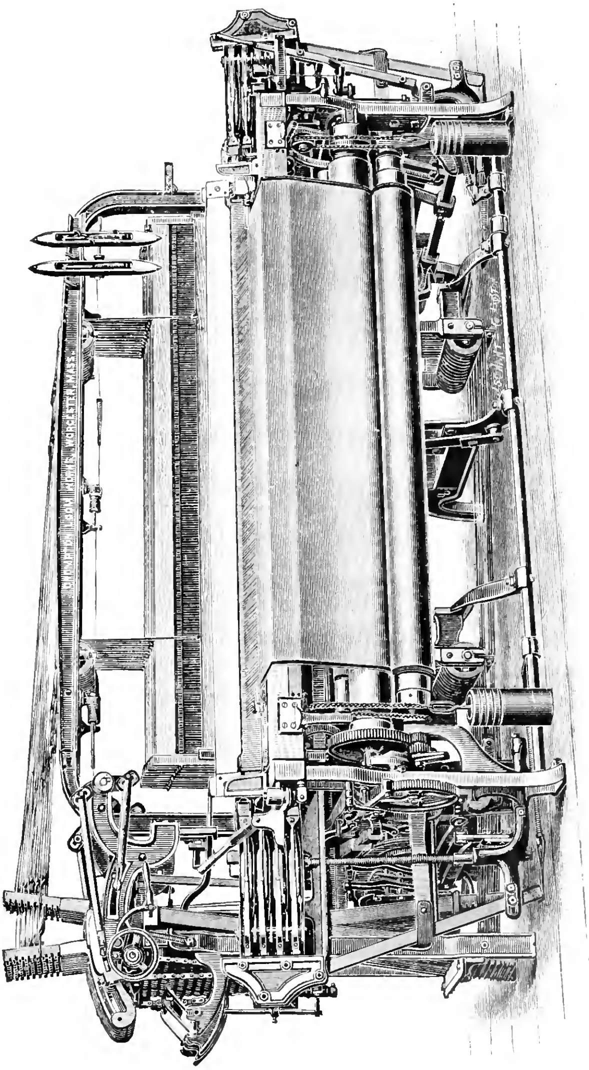


Fig. 25.—The Crompton Thirty-six Harness Worsted Loom.

textile industry. But it is out of place in a paper that relates to the mechanical evolution of that industry. Machinery has done more than its share to assist human ingenuity in the devising of new and attractive variations upon the fundamental weaves. A loom in which thirty-six harnesses can be worked automatically suggests variations of pattern which are practically infinite.

These looms, with the aid of the Jacquard attachment, have enlarged the field of art in woolen fabrics, so that it now presents a limitless opportunity for the play of genius. In this direction we may look for constant advances. In recognition of the opportunity, textile schools for the better education of those who have to do practically with the manufacture have been established in the chief manufacturing nations of the Continent and in England. The influence of these schools upon the character of woolen fabrics is increasingly perceptible and is most gratifying. It is this influence which to-day constitutes the chief advantage which foreign manufacturers possess over those of the United States in the woolen manufacture. Nor can we hope to equal their achievements in this country until we have supplied the means for the better technical education of those who determine the character of the fabrics made in the American mills. In machinery equipment, and in all appliances for economical production, our best mills are fully abreast of the best foreign mills. But in the character of our products we continue to be imitators rather than originators.

MAN AND THE GLACIAL PERIOD.*

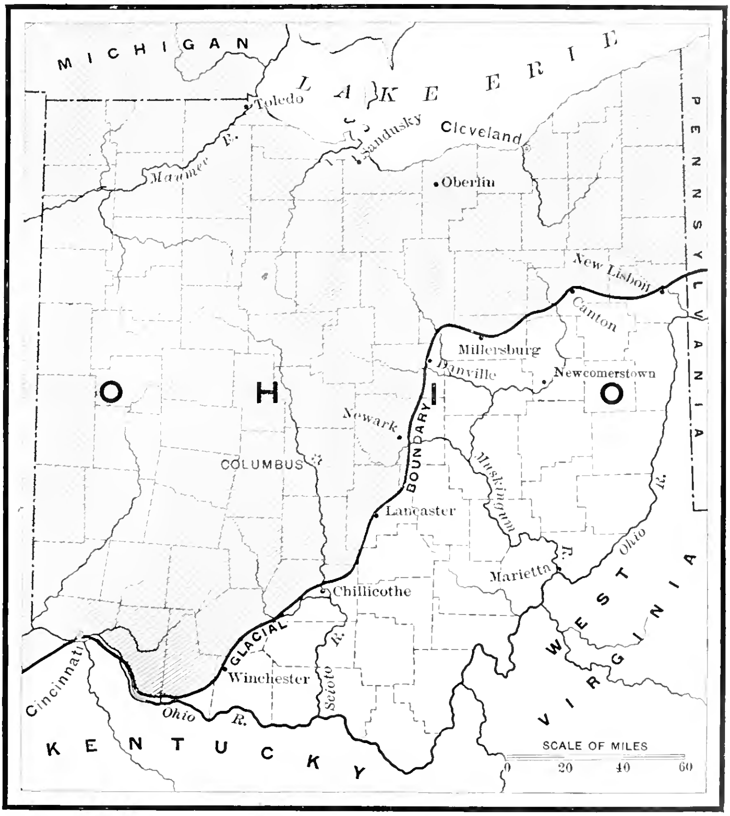
By Prof. G. FREDERICK WRIGHT.

SOME most important facts have come to light during the past two years bearing upon the connection of man with the Ice age in North America.

In October, 1889, Mr. W. C. Mills, president of a local archæological society of some importance at Newcomerstown, on the Tuscarawas River, in Ohio (see map), found a flint implement of palæolithic type fifteen feet below the surface of the glacial terrace bordering the valley at that place. The facts were noted by Mr. Mills in his memorandum-book at the time, and the implement was placed with others in his collection. But, as he was not familiar with implements of that type, and did not at the time know the significance of these gravel deposits, nothing was said about it until meeting me the following spring, when I was led from his account to suspect the importance of the discovery. Mr. Mills soon after sent the implement to me for examination, and its value at once became apparent. In company with Judge C. C. Baldwin and two or three other prominent citizens of Cleveland, I immediately visited Newcomerstown. A cut of the implement is given in the accompanying pages, made from a photograph one

* From supplementary notes to the new edition of The Ice Age in North America, and its Bearings on the Antiquity of Man. New York: D. Appleton & Co., 1891.

quarter the diameter. Beside it is a palæolith which came into my possession from Dr. Evans's collection in London, with his certification that it is from the valley of the Somme. The two implements, as they appear side by side, are in shape and finish the exact counterparts of each other. The one from Newcomerstown,



however, is made from a local flint which occurs in nodules in the "Lower Mercer" limestone, which is situated in the lower part of the coal-measures, and crops out a few miles from there.

The implement has upon it the patina characteristic of the genuine flint implements of great age in the valley of the Somme, and is recognized by Prof. Haynes, of Boston, as in itself fulfilling all the requirements looked for in such a discovery. The gravel-pit in which it was found is one which for some years has been resorted to by the railroads for ballast. Mr. Mills saw the implement as it was projecting from the undisturbed gravel in the fresh exposure, and took it out with his own hands. The surface of the glacial terrace is here thirty-five feet above the present high-water mark of the river, and, as already said, the implement was found fifteen feet below the surface. The terrace is one which characterizes the Tuscarawas River everywhere below the glacial boundary. Additional interest is given to this discovery by the fact that it is from one of the valleys to which I had directed attention several years before as likely to yield such discoveries.

The other most important facts bearing on the antiquity of man come from the Pacific coast, and perhaps have only an indirect connection with the Glacial period; but as their connection

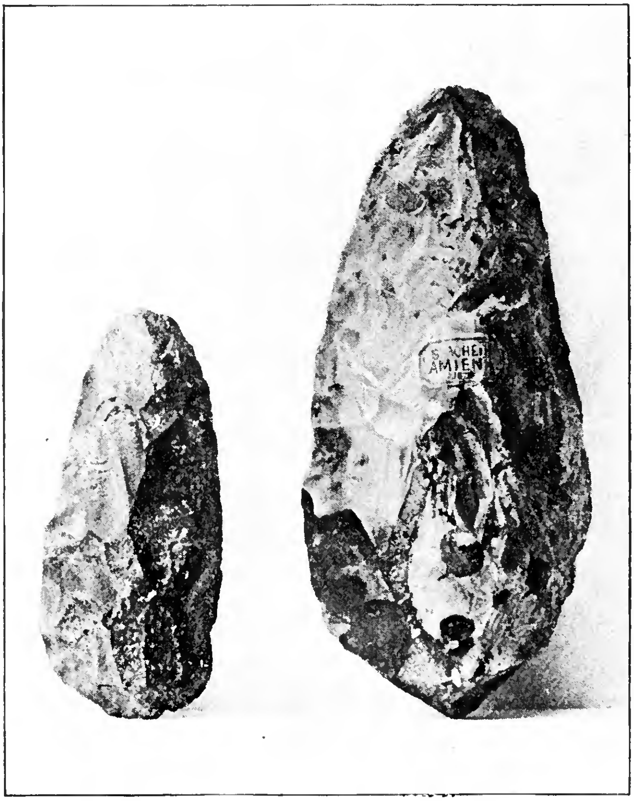


Fig. 1.—The Smaller is the Palæolith from Newcomerstown, the Larger from Amiens (face view).

with the period must stand or fall with the facts collected some years ago by Prof. Whitney, I will allude to them here.

In the autumn of 1889, Mr. Charles Francis Adams, then President of the Union Pacific Railroad, brought to my notice a small clay image, an inch and a half in length, which had been found by Mr. M. A. Kurtz while boring an artesian well at Nampa, Ada County, Idaho. The image was of slightly baked clay, incrusted in part with a coating of red oxide of iron, which indicated considerable age, and came up in the sand-pump from a depth of three hundred and twenty feet. Near the surface the well penetrated a stratum of basalt, fifteen feet thick. Below this basalt there were alternate beds of clay and quicksand to the depth mentioned, where the sandstone rock was encountered. The well was tubed with heavy iron tubing six inches in diameter, so that there could be no mistake about the occurrence of the image at the depth

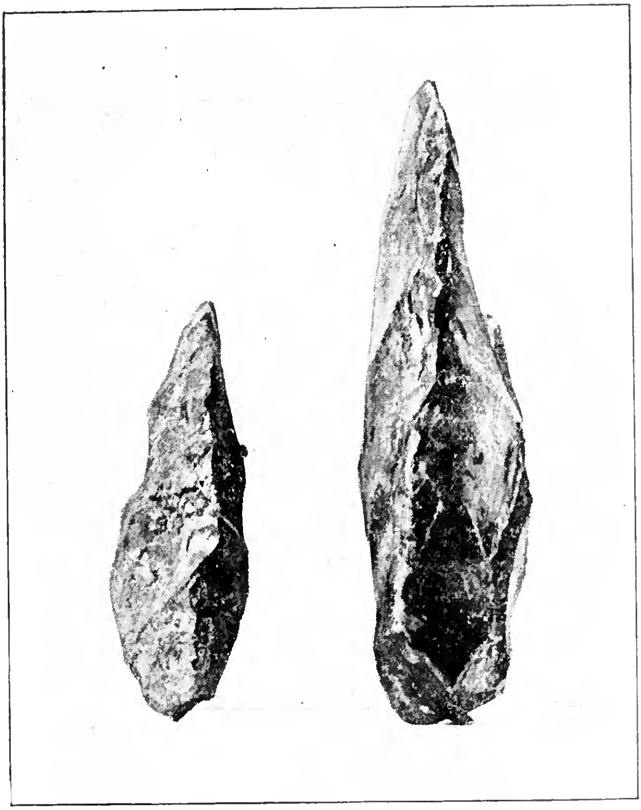


Fig. 2.—Edge View of the Preceding.

stated. The detailed evidence was published by me in the Proceedings of the Boston Society of Natural History for January, 1890. During this last summer, also, I visited the locality and found ample confirmation of it.

In the valley between the Boisé and Snake Rivers, in south-western Idaho, where Nampa is situated, there is an area of several hundred square miles covered with fresh-appearing basalt, which apparently came from vents thirty or forty miles to the east, but in its western flow barely extended five miles beyond Nampa. Below that point there is no lava for seventy miles. The clay and quicksand covering the stratum in which the image was found would seem to have accumulated in the valley of a stream having access to such an amount of sedimentary material that for a time it filled up rather than eroded its channel. Apparently the conditions favorable to such effects would be most readily furnished during the Glacial period, when the streams of that region were swollen not only with the increased annual precipitation, but with the melting of the glaciers which doubtless had for a long time occupied the mountains near the head-waters of the Boisé River to the north. Very likely, also, the lava-flows which obstructed the river a few miles above Boisé City turned its course to the southward, so that it may have wandered for some time over the plain in the vicinity of Nampa.

From the erosion of the Boisé River since the outflow of lava it would seem that the time which has elapsed since the volcanic outbursts is closely comparable with that which has passed since the outflow of the lava forming the Table Mountain in Calaveras and Tuolumne Counties, California, under which the famous Calaveras skull was found some years ago. Furthermore, the occurrence of late Pliocene fossils underneath the lava in western Idaho shows that the lava at Nampa is certainly post-Tertiary, so that this discovery of human relics may properly be synchronized with those under Table Mountain in California.

In a visit to Sonora, California, and to Bald Mountain, where the Calaveras skull was discovered, I was so fortunate also myself as to run upon evidence of a previously unreported instance of the discovery of a stone mortar under Table Mountain. The mortar was found in October, 1887, by Mr. C. McTarnahan, the assistant surveyor of Tuolumne County. It was lying in the gravel reached by the Empire Tunnel, and about a mile west of the Valentine shaft where Dr. Snell found a similar relic. This tunnel had been excavated seven hundred and fifty-eight feet before reaching the gravel, and the mortar was found one hundred and seventy-five feet in a horizontal line from the edge of the Table Mountain basalt, and about one hundred feet below the surface. The object was taken out and laid beside the mouth of the tunnel, and was given to Mrs. M. J. Darwin, of Santa Rosa, California, who has since given it to me. The mortar is made from a small bowlder of some eruptive rock, and is six and a half inches through; the hollow being about three and a half inches in diameter, and about three inches deep.

At the annual meeting of the Geological Society of America, in January, 1891, a similar mortar was reported by Mr. George F. Becker, of the United States Geological Survey, as found under Table Mountain, about five miles south of the Empire mine, near Rawhide Gulch. Mr. J. H. Neale, a well-known mining superintendent, made his affidavit that he took this with some other objects of human manufacture from undisturbed gravel underneath the mountain in 1879. At the same meeting of the Geological Society Mr. Becker presented a pestle with a communication from Mr. Clarence King, stating that he found it, about twenty years ago, and took it with his own hands from undisturbed gravel under Table Mountain in the vicinity of Tuttletown, not far from Rawhide Gulch, and still nearer to the Empire mine.

Thus the evidence establishing the occurrence of human relics under Table Mountain would seem to be sufficient, and I should not now repeat the doubts expressed at former times concerning their genuineness. What the final conclusions will be as to the date of this lava-flow, it is now too early to surmise.

SANITARY IMPROVEMENT IN NEW YORK DURING THE LAST QUARTER OF A CENTURY.

By General EMMONS CLARK.

DURING the quarter of a century (1836–1860) preceding the war for the Union, a great change occurred in the character and social condition of the population of the large cities upon the Atlantic seaboard, and especially in the city of New York. The famine in Ireland, and the extreme poverty of the people of that unfortunate country; the unsuccessful revolutions in various parts of the Continent; and the popular belief that Fortune beckoned the poor and oppressed of foreign lands to comfortable homes and to personal, political, and religious freedom beyond the Atlantic, were chief among the causes of the immense emigration at that period to the United States. Immigrants of some pecuniary means and from agricultural districts generally located upon the fertile plains of the Western States, and contributed by their industry and frugality to the rapid growth of new commonwealths. But a very large number, from choice or necessity, and especially the indigent, found homes in the large cities on the sea-coast, and New York received and retained more than its share of the immigrants who were least desirable as a permanent addition to its population. Previous to this tidal wave of immigration, the city was peopled mainly by the descendants of its staid Dutch founders, their thrifty English successors, and the active and enterprising sons of New England. Their dwellings were generally small and inexpensive, and were owned or occupied by single families of moderate income, and the habitations of the more wealthy were quite unpretentious. With the advent of Irish and German immigrants, houses constructed for the comfortable accommodation of single families were transformed to shelter many; their cleanliness and healthfulness disappeared with the numerical increase and change in the character of the occupants; and new, large, and badly lighted and ventilated buildings were erected as domiciles for immigrants from foreign lands and the native poor. It was at this period and under these circumstances that the tenement-house system of New York was inaugurated, since famous for its extent, and for a long time infamous for its character and influence.

Native-born citizens viewed with considerable apprehension and dissatisfaction this great influx of foreigners, with their diverse languages, customs, and religions; to avoid unpleasant associations they reluctantly surrendered their dwellings and found new homes in the more northerly part of the island, or beyond the East River, in Brooklyn; and this migration continued until large sections of the city were almost entirely occupied by tenement-houses. In all such districts the sanitary condition, which had been fairly good, rapidly deteriorated; the municipal government made no effort to enforce regulations necessary to insure cleanliness and to promote the health and comfort of the poor and helpless; and thus between the years 1830 and 1860 a considerable part of the city year by year drifted into a condition deplorable to the philanthropist and disgraceful to the corporation. The wiser statesmen of that period urged that universal education would be more effective than proscription in removing the acknowledged evils from this immense immigration, and that proper laws and regulations to promote thrift, morality, cleanliness, and health were the true panacea. Free schools for all the people, after a long struggle, were authorized and required by statute. Although the necessity of sanitary reform and improvement was evident, it was not until 1864 that an organized and intelligent movement was made to remove the evils which had gradually accumulated and which seriously threatened the health and permanent prosperity of the metropolis. The great draft riot of 1863, when the city was for several days controlled by the ignorant and dangerous classes, a large amount of property destroyed, many lives lost, business suspended, and the streets unsafe for traffic or passage, was largely instrumental in awakening the New York public to the absolute necessity of reform and improvement in the social condition of a considerable portion of its population.

On the 29th day of February, 1864, at a meeting of the Citizens' Association, at that time an organization of great activity and influence, and composed of the most prominent intelligent and public-spirited citizens of New York, a committee of inquiry was appointed to obtain full and reliable information relative to the sanitary condition of all parts of the city. Upon the report of this committee a Council of Hygiene and Public Health was organized, and under its direction a thorough sanitary survey of the city was made during the year. The city was divided into twenty-nine sanitary districts, and to each district was assigned a competent physician as sanitary inspector, to make a house-to-house visitation, and to report upon every possible source of preventable disease and every nuisance dangerous to life or detrimental to health. The tenement-houses of the city were a special subject of inspection, the inquiry extending to their cleanliness, ventilation, drainage, and water-supply, the disposal of refuse, location and care of water-closets, number of families and amount of air space, cellar population, and the sickness and mortality. The work was faithfully and intelligently accomplished, and in 1865 the reports of the Council of Hygiene and Public Health and of the sanitary inspectors of districts were published in a large volume. These reports were so startling in their disclosures, and the advent of Asiatic cholera was at that time so imminent, that public attention was directed to the subject, and it was not difficult to secure the enactment by the New York Legislature of 1866 of "an act to create a Metropolitan Sanitary District and Board of Health therein, for the preservation of health and life, and to prevent the spread of disease." This act clearly defined the duties of the Board of Health, and conferred upon it discretionary powers, judicial and legislative, never before intrusted to any executive body in this country. Under this law the Board of Health was organized in New York March 5, 1866, and on the 20th day of April it enacted the necessary sanitary rules and regulations for the government of the city, since known as the Sanitary Code.

To demonstrate the sanitary improvement in New York during the quarter of a century that has elapsed since the organization of the Board of Health in 1866, it is necessary to briefly describe the sanitary condition of the city as it appeared to the Council of Hygiene and its sanitary inspectors in 1864. They reported that the death-rate was largely excessive by reason of the great mortality from contagious and preventable diseases; that the tenement-houses of the city, especially those occupied by many families, were overcrowded, unclean, badly lighted and ventilated, imperfectly drained, supplied with large open privies, which were extremely filthy and offensive, causing discomfort and disease among the tenants, and that the manifold evils of the tenement-house system were intensified in many cases by rear houses in close proximity to those fronting on the street; that many dark, damp, and unwholesome cellars were used as human habitations and crowded with tenants and lodgers; that most of the public streets were paved with cobble-stone, out of repair and very imperfectly cleaned, and were a place of deposit for ashes and garbage; that a large part of the business of slaughtering animals was conducted in the tenement-house districts in dilapidated buildings and sheds, which were filthy and in some cases not sewered, the appliances used being inadequate and primitive, and the methods, especially from their publicity, indecent and demoralizing; that cattle were driven through the public streets in populous quarters with great danger to life; that the plumbing and drainage of dwellings, private as well as tenement houses, were extremely defective, allowing sewer-gas to freely escape into the apartments; that offensive odors from gas, fat-melting, and other manufacturing establishments were not uncommon; that stables were generally without proper drainage and very offensive; and that stable manure was allowed to accumulate, was removed irregularly and in an offensive manner, and was stored for sale in the vicinity of dwellings; and that the removal and disposal of offal, dead animals, and night-soil were conducted in a primitive manner disgraceful to a civilized city. It was also reported that there was no proper supervision and care by public authority of contagious diseases or to prevent their spread; that there was no public inspection of the food-supply of the city, and especially of milk, meat, and fish; that there were no regulations or inspections for the purpose of insuring to new buildings proper light, ventilation, and drainage, or to secure the correction of defects and the proper cleanliness of buildings already occupied as human habitations; in short, that the public health received no intelligent consideration from the municipal government, and that the demoralization incident to filthy streets and dwellings and to other unsanitary conditions threatened the material prosperity and the moral and social welfare of the city. Such was the situation in general, as graphically described by the Council of Hygiene, when the Metropolitan Board of Health commenced in March, 1866, the great work of sanitary reform and improvement.

Sanitary reform is of slow growth; for every improvement is an attack more or less important upon the prejudices or the property of a considerable number of citizens and tax-payers, and is, therefore, vigorously resisted. The action of the sanitary authorities of New York has been conservative and conciliatory, but firmly and steadily progressive. By persuasion and explanation important sanitary changes and improvements have been inaugurated, and, when approved by the common sense of the more intelligent and public-spirited, have been completed by legal compulsion; sanitary rules and regulations have been constantly enforced by an expert and vigilant corps of educated inspectors; and thus by a faithful and persistent public service, and without excitement or startling innovations, New York has been gradually relieved of the nuisances which afflicted its people and threatened its prosperity a quarter of a century since. For several years the Croton water supply, so important and essential to the health and welfare of the people, failed to meet the wants and necessities of the rapidly increasing population, but in 1890 the new aqueduct brought relief; and the only important particular in which no sanitary improvement has been visible is in the cleanliness of the streets and in the removal of the ashes and garbage of the city. It is not creditable to the municipal government that so simple a business problem has not long since been satisfactorily solved.

1. THE DEATH-RATE.—The death-rate of a city for a series of years fairly represents its healthfulness and general sanitary condition. During the ten years, 1851–1860, the average death-rate in New York was 33·66 per 1,000 of its population, or, omitting the year 1854, when Asiatic cholera increased the mortality to 44·36, the death-rate for the period was 32·46. For the five years previous to 1866, in which year practical efforts commenced under ample provisions of law for the sanitary improvement of the city, the average death-rate was 31·33. During the quarter of a century ending in 1890 the death-rate steadily decreased, with the variations from year to year due to climatic and other recognized causes, from 31·33 in 1861–1865 to 25·54 in 1886–1890, the rate in 1890 being 24·58 per 1,000 of the population. This decrease in the death-rate in twenty-five years of 5·79 per 1,000 represents a saving of about 3,300 lives in each year, the average population for the whole period being estimated at 1,153,646, and of over 80,000 lives during the quarter of a century. As the number of cases of sickness is estimated to be twenty-eight to each death, it is obvious that a large amount of suffering has been prevented by improved sanitary conditions, and that the pecuniary benefit to the laboring class and to the poor, consequent upon exemption from expenses attending sickness and death and from incapacity for employment incident to disease, is of great value and importance.

Although a steady decrease is shown in the rate of mortality in New York, it is, from a variety of circumstances, considerably higher than in some of the large cities of this and other countries, and the difference is likely to continue for a considerable period. In no other city is the population so dense and crowded; suburban homes for laboring people so difficult and expensive to reach; small dwellings for people of moderate means so unattainable; and large tenement-houses sheltering many families so necessary and indispensable. No other city receives into its charitable institutions so many weak, sickly, and indigent persons from foreign countries. Its extensive public institutions of charity and correction, all situated within the city limits, are largely recruited from adjacent villages and cities, and its numerous private hospitals receive persons from all parts of the country for surgical and medical treatment. These and other circumstances contribute materially to the mortality of New York, and, while they continue to exist, its death-rate can not be expected to compare favorably with that of cities more exclusive in respect to the inmates of their public institutions, with comparatively no immigration from other countries, and with the superior sanitary conditions incident to a scattered population and to small and healthy abodes for single families.

2. Tenement-houses.—Under an act of the Legislature of 1867 "for the regulation of tenement and lodging houses in the cities of New York and Brooklyn," the improvement of this class of houses commenced, and it has been continued under subsequent enactments with the following results. To improve the light and ventilation of tenement-houses, windows to the halls have been introduced in dark rooms, transom windows over the doors, and ventilators in the roofs over hallways. Privy-vaults and cesspools have been banished, and school-sinks and hopper-closets in the yards, or water-closets and kitchen sinks within the dwellings substituted, all connected with the street sewers. Defects in plumbing and drainage have been removed, iron soil-pipes substituted for imperfect earthenware drains where necessary, and new and improved appliances introduced when practicable. By frequent and thorough inspections by sanitary officers, overcrowding is prevented, cleanliness is encouraged among the tenants, and the necessary repairs and whitewashing secured from owners or agents. In addition to the inspections made upon complaints, and in the course of routine sanitary work, a wise and salutary provision of law now requires that all tenement-houses should be inspected twice yearly. The education of the inmates of tenement houses in habits of cleanliness and as to the importance of minor sanitary rules and regulations, a legitimate result of these frequent inspections and of the visits of a large corps of medical inspectors during the summer months, has been invaluable to the public health. But so long as New York remains the objective point of emigration, and until temperance, frugality, and morality are universal, the ignorant, indigent, intemperate, and irreclaimably vicious part of the population must be an extensive field for the philanthropist and the sanitarian.

The improvement in the plans for light and ventilation, plumbing and drainage of tenement-houses recently erected is the great sanitary achievement of the last quarter of a century. For a long period the standard tenement-house erected in New York was an oblong brick box upon the ordinary city lot, twenty-five by one hundred feet, covering nearly the entire space, four or five stories high, imperfectly lighted and only from front and rear, halls and sleeping-rooms narrow, dark, and unventilated, with no bath, washing, or proper privy accommodations, and generally without Croton water within the building. Not infrequently this plan of construction was modified by placing a front and rear house upon the same lot, with a narrow alley between, thereby accommodating a greater number of families and more effectually depriving them of air and light. An act of the Legislature of 1879 required that the plans and specifications for light and ventilation of all tenement-houses thereafter erected be filed with the Health Department and receive its official approval before work can commence; and in 1881 a similar requirement was applied to plans and specifications for the plumbing and drainage of all new buildings. Owners, builders, and plumbers are required to construct buildings according to the approved plans, and are vigorously prosecuted for any violation. Sanitary engineers are detailed to inspect as often as necessary every building in course of construction, to report violations of plans and specifications, to thoroughly test the plumbing, and to report the satisfactory completion of all work before the occupation of the building is permitted. As the result of this important sanitary work, the New York tenement-house recently built is a model structure and can hardly be improved. A clear, unobstructed space of ten feet is required at the rear of every such house, with open courts in the interior sufficient in size to afford light and ventilation to every room. At least one water-closet with suitable appliances for flushing, well lighted, and ventilated by a separate air-shaft, must be provided for every fifteen persons. The cellars are lighted by windows to the external air, their floors are concreted, and their ceilings plastered or sealed with boards. The old hydrant in the yard, with its cesspool for receiving the slops and liquid waste of many families, has disappeared, and water is supplied to each apartment with suitable kitchen sinks and wash-tubs. The plumbing and drainage conform to the most approved system, and earthenware pipes with leaky joints, and untrapped and unventilated waste-pipes, are unknown in the modern tenement. The old tenement-houses are rapidly yielding to the encroachments of business, and are replaced by factories, stores, and warehouses; and this fact, together with the proper enforcement of the laws and regulations in respect to the erection of new houses and the conversion of private dwellings to the use of many families, practically solves the tenement-house problem.

3. LODGING-HOUSES.—The laws relating to the light, ventilation, plumbing, and drainage of tenement-houses in New York also apply to the numerous lodging-houses which shelter for a night at cheap rates the unemployed laborer, the homeless poor, and in some cases the vagrant and the outlaw. Twenty-five years since no supervision or sanitary control was exercised by the public authorities as to the character or condition of apartments used for lodgers of this class; and cellars, dark, damp, and unventilated, were commonly occupied for this purpose and were distinguished

for their uncleanliness and foul odors, and as the prolific source of pestilential disease. All such cellars have since been vacated, and the use of apartments below the street level for lodgers is now prohibited. Without a permit from the Health Department a lodging-house can not be maintained, and permits are granted only after a careful survey of the premises, and upon official reports that the buildings and fixtures conform to the laws and to the Sanitary Code. The number of lodgers allowed in each room is proportioned to the air space, four hundred cubic feet being the minimum for each person; and the overcrowding of lodging-houses is prevented, and the condition of the permits and proper sanitary rules are enforced by frequent official inspections, often made after midnight. In no particular is recent sanitary work more commendable than in the improved condition of the premises which for a pittance harbor with decency from night to night those unfortunate persons who, from want of employment or some other more deplorable cause, lead a precarious and nomadic existence, but have not yet become objects of public charity.

4. Slaughter-houses.—In 1865 there were one hundred and seventy-three slaughter-houses in New York, and many of them were located in the most populous parts of the city. After a long controversy they were removed from below Fortieth Street, and at a later period to limited districts on the North and East Rivers, and the business is now conducted without public or indecent exposure, in suitable buildings or abattoirs constructed especially for the purpose, with tight floors and proper sewer connections, and with the most improved appliances for utilizing all parts of the animals slaughtered, or disposing of them without offense. Cattle are not driven in the public streets, but reach the slaughter-houses directly from boats, and the adjacent cattle-yards are properly paved and drained. The daily and weekly inspection of these establishments by sanitary officers have secured habitual cleanliness and the observance of the necessary rules and regulations. By these changes and improvements an important industry, which for several years was threatened with banishment, has been retained within the city limits, with benefit to the food-supply and without detriment to the public health. The number of slaughter-houses or abattoirs in the city is now about thirty, and many of them are model establishments in construction, appliances, and management.

5. Stables and Stable Refuse.—The connection of stables with the street sewers, formerly the exception, is now the rule, and cleanliness and the regular and frequent removal of manure are required. Manure-vaults are only permitted as temporary receptacles; stable refuse is not allowed to be loaded in carts upon the sidewalk or from openings in vaults beneath; the carts are re-

quired to be tight and properly covered, so that no part of their contents will escape into the street during transportation to boats or cars; and the storage of this material in any part of the city is no longer tolerated. While so large a number of horses (estimated at sixty thousand) are in daily use for business and pleasure, the necessary stables and refuse must continue to be a subject of constant sanitary care and attention.

6. OFFENSIVE TRADES.—The business pursuits commonly called "offensive trades" are those which, if conducted carelessly and without the proper machinery and the necessary chemical appliances, become a nuisance detrimental to health. Twenty-five years since there were no proper public or official supervision and control of these pursuits, and they were only restrained from vitiating the atmosphere with smoke, dust, and foul odors by an appeal to the courts and by tedious and expensive litigation. Prompt attention to all complaints, frequent inspections, orders to discontinue business unless conducted without offense, and a vigorous enforcement of the health laws by the sanitary authorities, have accomplished the desired object. Mechanical and chemical devices have been successfully introduced whenever necessary, and it has been completely demonstrated that there is no business pursuit of importance which can not be conducted inoffensively in a large city, if the buildings used are properly constructed, the machinery and methods are thoroughly scientific and practical, and due care and supervision are constantly exercised. The manufacture of illuminating gas, prolific of odors if conducted without the necessary care and expense, has been a subject of frequent complaint, and although efforts for the public relief have often encountered a vigorous resistance, fortified by corporate wealth and the necessity and universal use of the product, the business has been deprived of its most objectionable features, and is comparatively free from offense. The utilization of the various parts of slaughtered animals not used for human food and the methods employed are among the most remarkable of modern sanitary improvements. The fat, which was formerly melted in open kettles, is now rendered in air-tight tanks; the blood which defiled the public sewers, and the offal, from time immemorial a disgusting nuisance, are converted into fertilizers; and the bones and other refuse animal material, by the aid of applied chemistry, have become useful and valuable as commercial articles. It is unnecessary to enumerate the great variety of business pursuits which formerly afflicted the community with smoke, dust, and foul or offensive odors, and which are now conducted without offense or complaint. Only one trade has been hopelessly ruined by sanitary reform during the last quarter of a century; the ancient guild of hereditary night scavengers, the terror of belated, sleep-

less, or dreaming citizens in midsummer nights, ceased to exist, when privy-vaults were generally banished from New York.

7. Care of Contagious Diseases.—The prevalence of contagious diseases, and the absence of official care and control a quarter of a century since, is illustrated by the following extract from the report of the Council of Hygiene, 1865 (page 137), upon the sanitary survey made in the previous year:

"With typhus fever and small-pox in nearly ten thousand domiciles of the poor and the ignorant, where every circumstance favored the localization of infection and the propagation of disease, and where gross nuisances and criminal negligence of cleanliness, ventilation, and medical police demanded the presence of intelligent authority, it is justly concluded that the work of sanitary improvement should, if possible, be enforced by legal authority. The records of many a fever-nest during this survey have shown that the legislative and judicial power of an intelligent Board of Health is indispensable. In some instances the incursions of fever into crowded tenements ravaged every family, and not infrequently broke up large families, making fatal victims of the parents and pauperizing their surviving dependants; often the fever has swept through the front and rear domiciles of populous tenement-houses, and thence has been widely diffused by the constantly changing tenants."

The result of official sanitary care and of improved methods is demonstrated by the vital statistics of that period and of the present time. The number of deaths from small-pox was 78 in 1863, 394 in 1864, and 674 in 1865; and from typhus fever 420 in 1863, 764 in 1864, and 501 in 1865. With a population more than doubled, the number of deaths from small-pox were 81 in 1888, one in 1889, and two in 1890, and from typhus fever four in 1888, none in 1889, and none in 1890. The average number of deaths from typhus fever for the ten years ending with 1865 was 291, and for the ten years ending with 1890 was 30, and the average number from small-pox for the same periods were 372 and 92 respectively. These remarkable results must be attributed to the improved sanitary condition of the city generally; to the prompt reports of all cases of contagious disease by attending physicians; to the immediate removal of the sick to hospitals by the health officers, when advisable; to the sanitary inspection of the premises where sickness has occurred, and the thorough disinfection of sick-rooms and of infected bedding and clothing; and to the new and commodious hospitals for contagious diseases erected and controlled by the sanitary authorities, in which the sick are completely isolated and receive the best care and medical attendance. In cases of small-pox, to prevent the spread of the disease, the persons who have been exposed to the contagion or reside in the immediate vicinity are vaccinated or revaccinated as may be necessary, and are held for the necessary time under official observation. Prior to 1866 free vaccination was obtainable only upon application to public dispensaries; now a corps of expert medical inspectors, by constant house-to-house visitation, offer vaccination to all and urge its acceptance. With the great decrease in typhus fever and small-pox official attention has been specially directed to scarlet fever, diphtheria, and minor contagious diseases; a hospital has been erected for the reception of cases that can not be isolated and properly treated elsewhere; and the same rules and regulations have been applied in respect to reports of cases by physicians, inspection of premises, isolation or removal to hospital, and disinfection of rooms, bedding, and clothing, with results so satisfactory and promising that there is reason to hope for a continued decrease in the sickness and mortality from these dangerous diseases.

8. The Food-supply.—The frequent inspections, by a corps of experts composed of physicians and chemists, have so improved the supply of milk brought to the city and offered for sale, that this important article is now rarely found diluted by water or otherwise impure. The markets for meat, fish, fruit, and vegetables are also regularly inspected, and the large amount of these articles seized by sanitary officers from time to time and removed to the offal docks as unfit for human food have improved the supply, checked the sale of whatever is unwholesome, and secured more care and caution on the part of dealers and consumers. Chemical analyses of various articles used as food and in its preparation have also resulted in the detection of frauds and the correction of abuses which formerly were not the subject of official interference or action.

9. Plumbing and Drainage.—The plumbing and drainage of tenement-houses have already been noticed, but the improvement of private dwellings in these particulars is not less important. Sanitary engineering during the past twenty-five years has become an important branch of science; in practical plumbing there have been remarkable improvements in material, fixtures, and workmanship; householders have been educated in the importance of excluding sewer-gas, odors, and dampness from their dwellings; and competent official supervision of new plumbing, and correction of defective work in houses erected at periods more or less distant, have removed many of the dangers which formerly threatened life and health in the abodes of the rich and the poor.

Several departments of the municipal government in the performance of their duties as prescribed by law have greatly contributed to the sanitary improvement of the metropolis during the last quarter of a century. The cobble-stone pavements have generally been replaced with block stone, and recently asphalt has been extensively introduced, thereby making clean and dry streets possible; the sewer system has been extended upon scientific principles, and antiquated and defective sewers removed; new piers have been constructed upon an established line and uniform plan, though the number has hardly increased with the commercial demand; loss of life and accidents from fire have been materially decreased by an admirably organized and disciplined department; and ample provision has been made for extensive public parks; and one of them, which is unrivaled for its beauty and perfection, notably contributes to the health and pleasure of the people.

It must not be inferred or understood, from this brief and general sketch of sanitary reform in New York during the last quarter of a century, that perfection has been reached and the work entirely accomplished. Important steps have been taken in the right direction, and wonderful progress has been made, but the field is wide and open for future activity and effort. The results can hardly be so extraordinary and revolutionary in a similar period, but the work will continue eminently useful in decreasing human suffering and the rate of mortality. To make the metropolis of the country a healthful and desirable place of residence for the rich and the poor, and attractive as a resort and a temporary abode for people of this and other lands, is an object not unworthy the energy, ability, and ambition of any American citizen.

DEPORTMENT OF SAVAGE NEGROES.

By PAUL REICHARD.

EVEN the most thoroughgoing accounts of the customs of savages rarely give full descriptions of their attitudes and bearing. Yet these are the points that strike the stranger most forcibly, and are most distinctly remembered by him. A comparison of them with the behavior of more civilized races and of the lower animals might also afford an interesting anthropological study. In my observations among the Bantu negroes, extending from Bagamoyo into the Congo territory, I have found, except for the diversities in the forms of salutation, a great uniformity in the attitudes of the people. My present account will be confined to tribes which have remained free from foreign influence.

The most salient features of the negroes' movements are a general liveliness and a hasty, jerky execution. Their speech is loud and is continually emphasized by gestures, which are a real constituent of the speech, and are made all the same when the conversation is carried on in the dark; and they are so expressive that it is possible to understand much of what is said without hearing a word of it.

If we suppose ourselves to visit the chief of a negro village, we shall find him sitting in the veranda of his hut with his nobles, and the braves who have come to pay their respects, around him. If it be still early in the morning, there may be here and there a man reclining on his side by the embers of last night's fire, with his head resting in his hands and his knees drawn high up. Most of the negroes sleep in this position, and their bed-places are accordingly so short that stretching at full length in them is attended by inconveniences. When awakened at last by the ascending sun, the sleeper gets himself into a squatting position, stretches his arms forward over his high-drawn-up knees, so as to balance himself, and slowly rises without his hands touching the ground. The accustomed attitude of the chief is to be sitting on a low stool with his arms resting upon his knees, smoking a pipe, while his officers are squatting around him. New-comers to the audience, making the usual salutations, advance carefully as if treading upon glass, and if nobles, and privileged to sit in the presence of the chief, bearing their stools, which they deliberately seat themselves upon. The caller then draws his knees closely up to his breast, lays one arm upon his leg, grasps one hand with the other, and stoops over till his chin nearly touches his knees; or he stretches his legs out, crosses his feet, and rests his hands upon his knees; but the negro men never cross their legs as we do, or spread them apart when they sit down. Nor do they sit in the Oriental fashion. They are fond of getting the forearm into a position where it will have some liberty, and playing with little sticks or straws. A curious position in sitting is with the heels supported against a stick and the toes resting upon the ground, while the legs are doubled upon themselves and the arms are left free from the elbow down. Some dispense with the stick and squat upon their heels, while only their toes touch the ground. They then have to use a stick, bow, or lance as a support.

The standing negro keeps his legs close together, with the knees inclining slightly inward, so that the feet touch and the great toes can play with one another. With his back somewhat bent, notwithstanding his broad shoulders and muscular figure, he gives the impression of a weakling. In one hand he holds his bow and arrows, while with the other he carries his spear over his shoulder. In time he will change his position, and, supporting himself by his right shoulder, will plant his left leg straight upon the ground, and set the sole of his right foot against his left knee, leaving the right knee to project forward at an acute angle. This is one of the most peculiar and characteristic attitudes of the negroes. If they rest their hands against their sides, it is always with the palms forward, never with doubled fists or the fingers turned backward. A common position is to lean toward a post, with the hand holding to it away up, but only the forearm coming in contact with the post. The negro sedulously avoids touching a tree or the walls of his house with his naked body, for fear of soiling his anointed skin.

At the special audience we witnessed, a messenger was received, with a report of a military expedition. He was called Fingamaguha, or bone-gatherer, from his habit of fixing in his curly locks a bone from every fowl he killed. In saluting the chief he put on a sober expression, halted, drew his limbs up, bent his knee so as not quite to touch the ground, and clapped his hands three times. Before approaching the powerful Wama chiefs, the messenger must besmear his body and face with mud and roll in the dust. Among the East Coast negroes the usual salutation consists, besides the customary phrases, in extending the hand. The Wanjamuesi lightly press the palms together and then draw them quickly over one another till only the middle fingers touch, when those fingers are snapped upon the thumbs. The Wama, west of the Tanganyika, in saluting lay their weapons on the ground, bow to the earth, and rub their arms, breasts, and foreheads with dust.

Women show their respect for the stronger sex by stepping sidewise out of the road and turning their backs to the man; or else they pass, assuming a position of trying to creep under something. In saluting one another the Wanjamuesi women make a half turn and a straight courtesy.

The chief beckoned to the messenger by stretching his arm out, with the back of the hand up, and making a motion of drawing with his finger two or three times under the inner part of his hand, as if he would draw the man in. Fingamaguha enforced his affirmative answer to the first question asked him by moving his chin backward and forward and lifting his eyebrows. Answering no to another question, he raised his shoulders and dropped them instantly. In expressing doubt, the negro draws his shoulders slowly down and inclines his head to one side; but he is not acquainted with any such sign as that of shaking the head in negation.

Previous to calling upon the messenger to begin his report, the chief offered him a cup of *pombe* or beer. The brave received it, supporting his extended right hand with his left. This using of both hands in acceping a gift—even if it be as insignificant a thing as a needle—is a matter of politeness. It emphasizes the importance of the present.

After prostrating himself, Fingamaguha began his story, holding one hand in the other, and accompanying each statement with its appropriate illustrative sign. To mark the time of making the attack, he turned to the east and pointed to the horizon with his hand; it was at sunrise. Having no division of the hours, the negroes thus mark the time of day by moving the hand till it points toward the spot in the sky where the sun would be at that hour. That the troop were fully armed and had their powder-horns well supplied was shown by the gesture significant of any fullness occasioned by a living being by pounding the right hand into the hollowed palm of the left so as to produce a dull sound. This sign is applicable to the filling of a dish, to an abundant harvest, or to a considerable collection of men or animals, but never to the overflow of a lake or water-course in the rainy season. The soldiers' patient endurance of their toilsome march was described with a series of nasal sounds and a backward and forward movement across the breast of the hands, with the palms turned toward one another; the empty condition of a deserted village which the company came upon, by waving his extended right hand in a curve from right to left up to his mouth and blowing into it; and, to emphasize the emptiness, drawing the hands rapidly over one another, and lightly clapping with them. The hunger suffered in consequence was depicted by slapping his hand several times on his shrunken belly. A motion of drawing the hands alternately one over the other, pulling at them as one would to pull off a glove, illustrated the enjoyment of a surfeit of provisions at another village. The same gesture may signify that all the inhabitants of a place have died or been killed. The storming of the enemy's village was described in a lively manner, with representations of the stealthy approach in the early dawn, and the sudden outbreak of the musketry, for which the symbol was "*To! to!*" as we would say "Boom! boom!" The manner of death of those who fell was illustrated by imitating the respective motions of using the weapons by which they were killed—the lance, bow and arrow, and gun.

Fingamaguha's narrative was received with mingled wonder and incredulity; and certain incidents, which had a humorous side, with boisterous laughter. A common attitude in listening was that of spreading the tips of the fingers over the upper lip, while the elbow was supported by the other hand; and the negroes may often be seen sauntering around in a similar attitude. When the story-teller's word was doubted, he fortified it by drawing his hand across his neck, as if to signify that they might cut off his head if it was not true.

The graces exhibited by the negroes in the dance that followed and was much admired by them, were not such as Europeans are pleased with. Their movements were shuffling, slovenly, and awkward, yet quick and vigorous, and were marked by holding the limbs and body as closely together as possible. All the dances have an obscene element, and, with the exception of the war-dance, suggest nothing higher than an exaltation of physical love. The war-dances, whether executed as entertainments or as a part of serious work, include a series of boastful, challenging movements. In those of the Wanjamuesi, a champion who has killed an enemy in battle executes an attack against a drum that stands in the middle of the circle of dancers. Approaching the instrument with great solemnity, or with leaps, he assumes a position like that of a theatrical hero who is fulfilling an oath of vengeance. With upraised lance he points to all the quarters of the sky, to indicate that he has performed his deeds everywhere. Then he looks wildly around, nodding his head energetically without bending his neck; nods a second time, holding his head straight up and only bending it forward; and again, with his whole upper body. In another war-dance one of the participants takes a lance or a stick and goes around the circle of dancers in a stooping position, stabbing at a feigned enemy who is supposed to be lying on the ground; then, leaping into the air, strikes at him horse-fashion, with one leg, but without touching any one. A common, peculiar movement of sand-shoving is regarded as a very imposing challenge. The performer, stooping a little, strides along with a gliding step, shambling at every few paces with his foot along the ground, so as to draw a line after him, then slowly raises his foot and pushes the sand forward. His impudent bearing gives the performance the offensive aspect it is intended to bear, which is emphasized by his kicking backward with most contemptuous gestures at his enemy, culminating with looking down between his legs at him. When a traveler in Africa, after a few rubs with the natives, finds them drawing lines with their feet in the sand, he may be sure that mischief is brewing against him. These, and a variety of other performances of similar import, are employed in earnest as well as in the dance and the sham battle; and even when death has reaped its harvest there still prevails a peculiar humor, with shout and song, and the adversaries continue to mock one another.

On occasions of grief the negro sits with his chin in his unsupported hand, slowly shaking his head. Weeping and shedding of tears are rarely witnessed. Mourning is exhibited by tearing the hair and a distressful howling.

Anger is manifested with great show of violence. The raging negro distorts his face, bites at his finger but without harming it, while the froth runs out of his mouth. The gesture of slinging away this froth with the middle and fore-finger is also employed in times of grief, or when anything unpleasant has occurred. The angry man beats around with his club, striking vessels, trees, the ground, and the roof-thatch, wisely taking care not to encounter any man, and is heartily glad when they hold him, take his weapon away, and try to quiet him. There is seldom any real clubbing. Appearing extremely angry, disputants stand opposite one another, calling names in voices of excited tones. If a real fight sets in, the bystanders interfere and separate them.

The negro is capable of great endurance in work when he makes up his mind to it. Field labor, felling of trees, and the women's stamping of meal are performed standing; other kinds of work in a squatting or sitting posture. In making his implements the negro has a correct eye for articles he has once learned to construct. His lances, arrow-heads, stools, and mortars are shaped very exactly. But he has little sense for straight lines. A common position at work is to sit with one knee drawn up to the chin, while the other leg lies bent upon the ground, with the feet touching; or the workman sets the soles of his feet together and spreads his knees out till he can work with both hands between them. Holding under his left arm the object to be fashioned, he draws his little sharp knife toward his body, cutting a thin, single shaving. The knife is held in the right hand, and pressure is applied from the third joint, counting from the tip of the fore-finger. The object is held by the thumb and fore-finger of the left hand, while the middle, fore, and little fingers of the same hand are utilized in pressing upon the back of the knife. The middle is the preferred finger in sewing, weaving, and other minor hand labors, and even in untying knots. The toes are very flexible, and are often engaged in holding goods on which sewing is done. Articles upon the ground, provided they are not too small or inconveniently large, are picked up with their aid. In climbing trees, the foot is planted against the trunk, and the great toe, spread out from the others, helps to secure the grip. An expert climbs with great skill and considerable speed, holding to the trunk with his hands extended as far as possible, and pressing against it with the soles of his feet, without touching it with his arms, legs, or body.

At eating, the negro, having always first washed his hands and rinsed his mouth, sits upon the ground; holds the larger pieces between his teeth while he cuts off a bite with his knife, but does not use both hands to hold food, except in gnawing bones; with the usual dishes, he lays his right arm over his knees and, reaching into the pot, molds the thick mess into lumps about the size of a walnut, which he throws into his mouth with a jerk, without scattering any of the food. To take out vegetables or soup, he presses a hollow into the lump and dips with it. Politeness is shown to the host or the housewife, after eating, by smacking loudly enough to be heard.

While the negro is capable of eating meat in an unpleasant state of decomposition, he is very sensitive against some tastes, and will make evident manifestations of his dislike of them. He is careful about the outer matters in drinking. He will always rinse his mouth first, even when he is intensely thirsty. If the cup is not too small, he takes it in both hands; and he likes to sit down with it. If the vessel is large and open, he draws in the water from the surface with his lips, without bringing them in contact with the dish. Sometimes negroes pour water into their mouths. When drinking at ponds and rivers, the water is carried to the mouth with the hand. For some mystic reason it is considered bad to lie flat down when drinking from rivers. The fear of being snapped up by a crocodile may have something to do with the matter.

Great attention is given in most of the tribes to the care of the body. The teeth are cleansed with a stick which has been chewed into a kind of brush. The hands are washed frequently, not by turning and twisting and rubbing them together one within the other, as with us, but by a straight up-and-down rubbing, such as is given to the other limbs. This manner of washing is so characteristic that an African might be distinguished by it from a European without reference to the color. The sun is their only towel.

The pocket handkerchief is as abhorrent to the negro as his manner of dispensing with it would be to us. The African finds a use unknown to us for his nose by making it a receptacle for carrying his roll of tobacco. Another tobacco-storage place is found behind the ears.

While joyous emotions are expressed in the most lively manner by negroes, signs of love and tenderness can hardly be read in their faces. The kiss is foreign to them, and no negro child has experienced the delight of being petted by its mother. The whole treatment of the child is neutral, and a matter of business. Signs of affection toward women from men are not permitted in public or in the presence of third persons. A negro man can only stare at a woman who pleases him. The women understand coquetry well, and, aside from a greater sensuality and lustfulness in expression, yield nothing in that respect to their white sisters. Marks of mutual regard are observed only among women, in embracings and hand-shakings.

The eye furnishes a very prominent mark of distinction between the white man and the black. The negro's eye usually gives an impression of shyness, which arises from the absence of any sharp line of distinction between the iris and the pupil. The resulting unsteadiness of the look gives the negro an expression of the animal which is not softened by his facial type. His assumed indifference often passes into consequentiality as when he pretends to know all about what one is showing him. His interest can be aroused only by objects the use of which is plain to him without explanation, or which he fancies have a market value. At them his eyes will shine with greed. Lack of self-confidence makes him suspicious, and his distrust appears in his look. His eyes will shine with his own rage, but no flame of noble indignation can be kindled in them on account of an evil deed or of a wrong of which he is the author.—*Translated for The Popular Science Monthly from Das Ausland.*

POLLEN: ITS DEVELOPMENT AND USE.

By JOSEPH F. JAMES, M. Sc.

WHEN a plant in growing has reached a certain stage in its development, the character of the buds which have before produced branches changes, and flower buds appear. In correspondence with the change of character in the buds, the stem and leaves change also. The former becomes smaller and forms the peduncle of the flower, while the latter, dwindling from true leaves or foliage organs, become bracts, sepals, and petals.

The process of flowering is attended with very important results. While the plant has been growing rapidly, sending out new leaves and branches into the air and new roots into the earth, the total amount of material produced by general growth has not been expended. A certain portion is kept in reserve, and this is drawn upon when the time for flowering and fruiting has come. It is the exhaustion of this reserve of food which causes annuals to perish after perfecting their seed. In biennials a store of matter is laid up one year in the leaves or roots, to be drawn upon by the plant when the flowering time comes round the next year.

Lamarck, about seventy years ago, was the first to detect that a certain amount of heat was evolved on the expansion of the flowers of the European *Arum*. Their *anthesis* is equivalent to a burning up of some of the material of the plant. The heat so produced is sometimes quite considerable, and it can be measured by means of a thermo-electrical pile. A most notable example of the consumption of stored material is to be observed in the century plant. This grows for many years, laying up nourishment in its large, succulent leaves. After from fifteen to seventy years' growth the time for flowering comes; the reservoir of nourishment is drawn upon, the flower stalk is shot up with tremendous rapidity, and in a few weeks the thousand blossoms have opened, faded, and seeded. Then the whole plant dies. It has exhausted its store of nourishment, and consumed itself in the production of seed. Dr. Gray has likened the plant to the fabled phœnix, which, consuming itself in giving birth to its offspring, literally rises from its ashes.

All the parts of a complete and perfect flower are, morphologically speaking, modified leaves. It can often be observed that true leaves pass insensibly into bracts. These in turn pass into sepals, and these again into petals. Sepals, being as a rule green, can be more easily seen to be modified leaves than petals. The last are usually colored, and the fact is not so noticeable. Yet, in the flowers of the cacti, the line between the outer bracts and the sepals, and between these and the petals, can not be drawn, for they pass imperceptibly into each other. In the *Nymphæa* (water-lily) there are numerous rows of petals, and a gradual change can be traced from the outer row of petals into stamens. First at the tip of a petal are developed two small lobes, one on each side. These lobes enlarge as the center of the flower is reached, and at last a fully formed anther at the top of a slender filament is the result. All the various stages through which the stamen has passed are visible in the rows of petals.

According to Mr. Grant Allen, the original and primitive flowers were made up of stamens and pistils only as the essential organs of the flower; and the petals and sepals are but stamens modified by insect agency. Now, whether petals are regarded as modified stamens or stamens as modified petals is immaterial. There is nothing to prevent the adoption of both views. The stamens must, in the first place, have been leaves; for it often happens that ordinary leaves are found bearing pollen grains on their edges. So, too, the anther is to be regarded as the modified apex of a rolled-up leaf. As the flowers became, in the course of time, more and more suited to insects, some of the stamens were doubtless changed back into leaves in the shape of petals and sepals, while at the same time the true leaves of the stem may have been changed into bracts of various sorts.

There will be noticed, on the examination of any ordinary stamen, two principal parts. One is the long, slender stalk or filament, and the other is the knob at the end, or the anther. The filament, says Sachs, is to be regarded as the staminal leaf. The anther is made up of two lobes, situated at or near the apex of the filament, one on each side, and separated by a prolongation of the filament known as the connectile. In these two lobes the pollen is developed. Sachs says that "the formation of . . . the pollen grains of phanerogams always takes place by the division of the mother-cell into four parts." This division takes place as follows: In the process of growth of the original mother-cell, the nucleus becomes divided into two parts, each soon forming the center of a new cell. These two again each divide and finally form four, each one surrounded by a cell-wall, but all still inclosed by the wall of the mother-cell (Fig. 1). On further growth the wall of the mother-cell is ruptured, and the daughter-cells escape as free pollen grains. The wall of the mother-cell is then either absorbed, or remains in the form of threads between the grains, or as viscid matter on the outside of the grains.

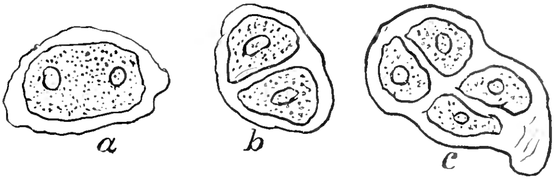


FIG. 1.—*a*, Mother-cell, with two nuclei; *b*, mother-cell divided into two cells; *c*, mother-cell divided into four cells.

Thus pollen grains are daughter-cells, which have been developed from a primal mother-cell. Each grain is made up of three parts. There is an outer wall (extine), an inner wall (intine), and the fluid contents (fovilla). The extine is often marked with lines, points, or grooves; the intine is generally smooth and regular, and, even when the extine is studded with points, the intine does not


Showing marks on extine. With extine removed.
FIG. 2.—HOLLYHOCK

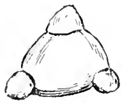


FIG. 3.—POLLEN OF ŒNOTHERA.

line the inside of these points but extends over their bases (Fig. 2). In cases where there are projections at different points, as in the evening primrose (*Œnothera*, Fig. 3) and others, the intine becomes thickened, and the extine is very much thinner. In the melon (Fig. 4), where the extine has pores provided with lids, the intine at these points is considerably thickened, and in growth pushes the cap off. When, again, a pollen grain appears marked with reticulations and spaces, as in *Pancratium* (Fig. 5), these are regarded as thinner places in the extine rather than special markings.

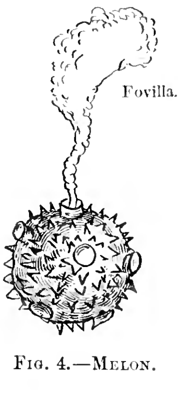


FIG. 4.—MELON.

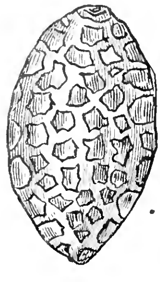


FIG. 5.—PANCRATIUM.

It is a well-known fact that the pollen of anemophilous or wind-fertilized plants differs markedly from that of entomophilous or insect-fertilized plants. In the former case it is dry and powdery, probably having this quality from the entire absorption of the wall of the mother-cell, thus leaving the grains separate in the anther. In entomophilous plants, on the contrary, the pollen is often viscid, or else studded with points, so that it may in some way adhere to the legs, bodies, or probosces of insect visitors.

While, as a rule, the pollen grains are free in the anther cells, there are two families, those of the *Orchids* and the *Milkweeds*, in which the grains are developed in a peculiar manner. In these families, but especially in the former, the grains cohere to one another by means of a viscid matter, and thus form one mass, technically known as a pollinium (Fig. 6). The cohesion is brought about by the walls of the mother-cells remaining, and so binding the grains more or less completely together. The cohesion is but slight, for, on the application of a pollinium to the viscid surface of a stigma, several grains are left on it, and thus one pollen mass will serve to fertilize several flowers. One of the most striking features of these pollinia is that the stem or caudicle undergoes on exposure to the air an act of depression (Fig. 7), so that while it stands erect on its first withdrawal from the anther cell, in a short time a contraction in the substance of the caudicle is observed, and then the pollinium becomes horizontal.

Fig. 6.—Pollinium upright.

While in ordinary cases pollen is yellow, there are instances in which this feature varies. For example, in one form of flower of loose-strife (*Lythrum salicaria*) it is green. In the willow-herb (*Epilobium angustifolium*) it is blue. In the tulip it is black, and in mullein (*Verbascum*) it is red.

The seeds of flowering plants are produced by the action of the pollen on the stigma. Though both bulb and seed bear in themselves the potentiality of the future plant, the two are very different. This difference can be well stated by saying that the bulb perpetuates the individual, and the seed the species. When the anther is nearly ripe, its inner wall becomes thinner and thinner, either along certain lines or in particular spots. The process continues until by pressure the wall is ruptured at these places and the pollen escapes. When the grains are placed upon the viscid stigma, the moisture absorbed by endosmose causes the contents to swell, and the intine bursts through the thin places in the extine and protrudes in the form of a tube, which penetrates the stigma to the ovary (Fig. 8). While the tube is at first only a projection of the intine, it afterward becomes a growth, for it is many times larger than could be contained in the grain. It is, therefore, nourished by the conducting tissue of

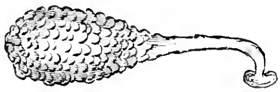


Fig. 7.—Pollinium after Depression.

the stigma. The fovilla, or the mucilaginous fluid filling the grain, proceeds by endosmose into the tube, and thence to the ovule. An effort has been made to disprove the statement that pollen tubes penetrate the style, and so fertilize the ovules; but the great mass of evidence, and the statements of many observers who have seen the tubes in contact with the ovules, indicate that the tubes sent out from the pollen grains *do* penetrate the style, and then are brought into contact with and fertilize the ovules.

It is a strange fact that pollen grains are often entirely inoperative on the stigmas of the flowers that produce them. It has been found by many experiments that, when certain flowers are inclosed in nets, and insects thus excluded from them, if the pollen be applied to the stigma of the flower that produces it, the capsules never set seed; but, if the pollen of another flower be applied, then the stigma is fertilized and seed is produced. In the California poppy (*Eschscholtzia*) there is a remarkable instance of this. Fritz Müller, in Brazil, found it completely sterile with its own pollen. Darwin, in England, found that even with the Brazilian stock of Müller he could get only a few seeds. Thus the sterility appears to depend on other things besides the pollen, the climate, perhaps, having some effect. Sometimes, too, it happens that, if the home pollen grows, and then foreign pollen be applied, this last grows faster and crowds out the first sort.

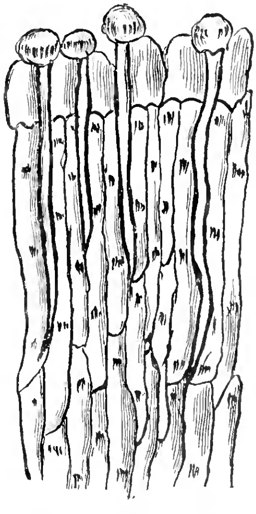


Fig. 8.—Pollen on Stigma of *Antirrhinum majus*. (After Brongniart.)

The immense number of pollen grains produced by a single flower apparently militates against the saying that Nature allows nothing to be formed but what is needful. It seems, indeed, a vast waste of material to have such a multitude of grains when so very few would answer the same purpose. In a single flower of the peony there are about three and a half million grains; a flower of the dandelion is estimated to produce nearly two hundred and fifty thousand; the number of ovules in a flower of the Chinese wistaria has been counted and the number of pollen grains estimated, and it is found that for each ovule there are seven thousand grains. While few fall below the thousands, many rise far above the peony in point of numbers. These are the wind-fertilized flowers, and here Nature must provide for an immense loss of material. Darwin says that "bucketfuls of pollen have been swept off the decks of vessels near the North American shore. . . . Kerner has seen a lake in the Tyrol so covered with pollen that the water no longer appeared blue. . . . Mr. Blackley found numerous pollen grains, in one instance twelve hundred, adhering to sticky slides, which were sent up to a height of from five hundred to a thousand feet by means of a kite, and then uncovered by means of a special mechanism." The so-called showers of sulphur which have at times visited various cities, notably St. Louis, are nothing but clouds of yellow pollen blown from pine or other forest trees from some distant place. Perhaps, out of millions of grains thus scattered far and wide, only a single one may be of service.

As if to compensate for this expenditure of pollen in some plants, there are others in which the amount is very limited, and where nearly every grain is made to count. These are known as cleistogamous flowers, a term applied to those which always remain in the bud. These flowers are found in plants belonging to about sixty different genera of various orders, and generally in those species which at the same time produce the normal and conspicuous flowers. These large blossoms are often sterile, and the plant must depend on the cleistogamous flowers for its seed. In the wood-sorrel (*Oxalis acetosella*), these flowers have each about four hundred pollen grains; the touch-me-not (*Impatiens*) has only two hundred and fifty, and some violets only one hundred. Even before leaving the anther cells the grains in these cases have protruded their pollen tubes; these seek the pistil and penetrate to the ovules.

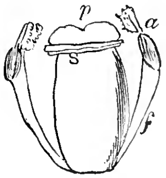


FIG. 9.—BARBERRY. *f*, filament; *a*, anther; *s*, stigma; *p*, pollen. (After Lubbock.)

It might perhaps be supposed that, as the seed can be produced so easily, all plants would have cleistogamous flowers. But here

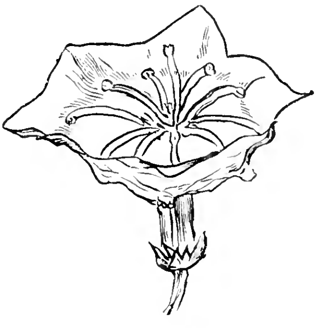
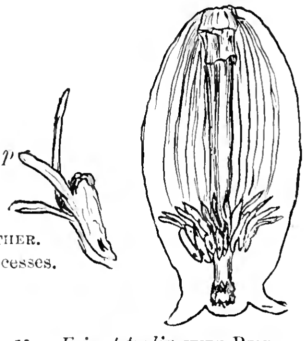


FIG. 10.—COROLLA OF *Kalmia*. (After Gray.)

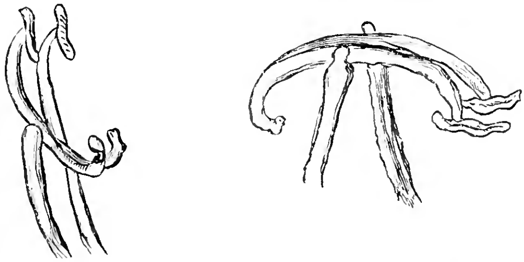


ANTHER.
p, processes.

FIG. 11.—*Erica tetralix*, WITH PENDENT ANTHERS AND PROCESSES. (After Lubbock.)

comes into play the fact that continual close fertilization is a great detriment and not a benefit, and that it is better in the end that flowers produce an apparently wasteful amount of pollen and take the chances of a cross, than to be more economical and be perpetually self-fertilized.

A few words now as to the movements of the stamens in connection with the ejection of the pollen. The contrivances for this are various. In the barberry (Fig. 9) the anthers are provided with valves which fly up and throw out the pollen when the base of the filament is touched. In the sheep-laurel (*Kalmia*, Fig. 10) the anthers are lodged in little pits on the corolla lobes, and the filaments are in a state of tension. The anthers open by terminal pores, and when the base of the filament is disturbed the anther is released from the pit and flies forward, this movement throwing the pollen out of the pores at the apex. The anthers of the heather (*Erica tetralix*, Fig. 11) are provided with processes projecting backward and nearly touching the sides of the corolla tube. As they have terminal pores, and are pendent, when the processes are jostled, as they would be by the visits of insects, a shower of pollen falls upon the visitor. Lastly, in the sage (*Salvia*, Fig. 12), the anthers are separated by a long connectile which is hinged at the top of the filament in such a way as to cause one of the anthers to come forward and downward when the other one is disturbed and pushed backward. They are at the same time so placed in the corolla tube that the movement is inevitable, and the distribution of the pollen certain, when an insect visits the flower.



Natural position. When moved by insect.

FIG. 12.—SALVIA. (After Lubbock.)

INSTANCES have been often reported in which fish have been frozen in cakes of ice and recovered their vitality when thawed out. Fish are mentioned in Franklin's journey to the polar seas that froze as fast as they could be taken from the net, so that they were split open with a hatchet, and yet became lively when placed before the fire. The phenomenon is referred to by Izaak Walton. Mosquitoes are said in the Quarterly Review to have been frozen on to the surface of a lake in the evening, and thawed again by the morning sun into animation. Alpine climbers sometimes pick up butterflies lying frozen and brittle on the snow, which revive and fly away when taken to the lower warmer regions. Insects which habitually hibernate, as larvæ or pupæ, do not suffer from being frozen for a lengthened time; but they suffer in open winters from frequent alternations of wet, warmth, and cold.

THE METEORITIC HYPOTHESIS.

By J. ELLARD GORE, F. R. A. S.

MUCH has lately been heard about the "meteoritic theory" as an explanation of the origin and construction of the heavenly bodies. This hypothesis, now generally ascribed to Prof. Lockyer, seems to have been first suggested by the German astronomer Meyer. His theory has met with some support from Helmholtz, Proctor, Thomson, and Tait in Europe, and from Profs. Newton and Wright in America. Prof. Lockyer has recently published a full exposition of his theory in an elaborate and interesting work entitled The Meteoritic Hypothesis: a Statement of the Results of a Spectroscopic Inquiry into the Origin of Cosmical Systems. In this volume the author has worked out his hypothesis in great detail, and, as his theory has recently met with much adverse criticism, a brief review of the principal factsa nd arguments advanced by Lockyer, and also by his opponents, may prove of interest both to those who accept and those who reject his views.

Lockyer commences his work with an account of the falls of meteoric stones recorded in history. The earliest of these dates back so far as 1478 B. C., but, of course, with some uncertainty. Numerous well-attested falls are, however, referred to, and many of these meteorites are preserved in museums, one weighing over three tons being deposited in the British Museum. This fell at Cranbourne, Australia.

The general form of these meteoric stones is fragmentary, indicating that they are the fractured portions of larger masses, burst asunder by the force of the explosion which usually accompanies these interesting phenomena. In the case of the meteorite which fell at Butsura in 1861, pieces picked up at places three or four miles apart could be actually fitted together to form the original mass.

Meteorites are generally covered by a black crust, clearly caused by the intense heat developed by the mass in rushing through the earth's atmosphere with a planetary velocity.

Meteorites are generally composed of well-known terrestrial elements. Among these may be mentioned iron, nickel magnesium, manganese, copper, carbon, sulphur, etc. Some of them, however, contain mineral compounds which are "new to our mineralogy," such as compounds of sulphur and calcium, sulphur with iron and chromium, etc. Some meteorites contain a large quantity of hydrogen gas, which has been absorbed or "occluded"; others contain carbonic-acid gas. Some are composed chiefly of iron, others mostly of stony matter.

Prof. Lockyer made a number of careful experiments on the spectra of fragments of "undoubted meteorites," obtained from the British Museum. These were examined at various temperatures, varying from that of the "Bunsen burner" to that of the electric spark with Leyden jar. He finds that, at the lowest temperature, the most prominent line of magnesium is a fluting near the wave-length 500. I may here explain that by the term "fluting" is meant a series of bright lines, usually three, which are sharp on the side toward the red end of the spectrum, but have a hazy fringe on the blue side. These "fringes," when examined with a powerful spectroscope, are seen to be composed of a number of fine lines very close together. In the case of "iron" meteorites, the lines of manganese are the first to make their appearance, owing to its volatility being greater than that of iron.

Lockyer finds that only the lowest temperature lines of magnesium, sodium, iron, chromium, manganese, strontium, calcium, barium, potassium, bismuth, and nickel are seen in the spectra of the meteorites.

He shows the probable identity of origin of luminous meteors and falling stars with meteorites, and also that comets are probably composed of meteoric stones. Discussing the observations of the aurora, he attempts to prove that the phenomenon is due to meteoric dust in the "higher reaches" of our atmosphere, and that the characteristic line seen in the auroral spectrum is identical with the brightest fluting of manganese. Dr. Huggins's researches, however, show that this coincidence does not exist; and some recent experiments made by Messrs. Liveing and Dewar with an electric discharge passing through dust show that the dust does not act like a gas, and does *not* become luminous like the aurora, but that, on the contrary, the electric current drives it out of its path.

Lockyer next proceeds to discuss the appearances presented by comets, and the character of the spectra they show at different distances from the sun, and concludes that their spectra very much resemble the spectra of meteorites seen under similar conditions of temperature. He considers that the light of comets is chiefly due to collisions between the component meteorites, and that the observed transparency of comets may be explained by supposing the meteorites to be small, and separated by considerable intervals. A portion of the light of comets, he thinks, may be produced by collisions between the cometic swarm and other swarms existing in space; and the recorded sudden increase of light in the Pons-Brooks comet of 1883, and the Sawerthal comet of 1888, seems certainly in favor of this idea.

Lockyer holds the view that both shooting-stars and comets did not originate within the solar system, but are of cosmical origin. This view of the origin of comets was held by the famous Laplace, but Kant thought they originated in the solar system; and the terrestrial origin of meteorites was advocated by Sir Robert Ball and Tschermak.

Lockyer then proceeds to discuss the probable construction of the nebulæ, and concludes that they are probably swarms of meteorites; the collisions between the component meteorites producing the light emitted by these objects. He attempts to prove that the brightest line seen in the spectra of the nebulæ, "the chief nebular line" as it is called, is coincident with the edge of the magnesium fluting seen in the spectra of meteorites. The nebular line certainly lies very near this fluting, but the spectroscopic power used by Prof. Lockyer was quite insufficient to decide so delicate a question. Recent observations by Dr. Huggins, with a more powerful spectroscope, and by Mr. Keeler at the Lick Observatory, with a higher power still, have, however, shown that the chief nebular line in the spectrum of the great nebula in Orion, and in some others, does *not* coincide with the edge of the magnesium fluting, but falls within the fluting, toward the blue end of the spectrum.

Classifying the stars in accordance with his theory, Lockyer places some of them on the rising branch of a temperature curve, and others, including our own sun, and stars with similar spectra, on the descending or cooling branch of the curve. From an examination of the spectra he considers that the red and orange stars of Secchi's third type, which includes many variable stars, are increasing in temperature, while the still redder stars of the fourth type, of which some are variable also, are cooling bodies, and are "approaching the extinction of their light." The stars showing bright lines in their spectra, he thinks, "are nothing more than swarms of meteorites, a little more condensed than those which we know as nebulæ." He identifies some of the bright lines visible in these stars with the lines of hot carbon, but this conclusion is disputed by Dr. Huggins.

Considering the subject of the binary or revolving double stars, Lockyer considers that they are merely condensed swarms of meteorites, which had probably their origin in a single nebulous mass, or a double nebulosity. He explains the phenomena of long-period variable stars by supposing one swarm to revolve round another in an elliptic orbit, the increase of light at maximum being caused by collisions between the meteorites of the swarms when they clash together at the periastron. This seems a very plausible hypothesis, and quite as probable, I think, as other theories which have been advanced to explain the phenomena presented by these interesting and mysterious objects. Bright lines have been observed by Espin in several of the most remarkable variable stars when near their maximum brilliancy, and these may very possibly be due to the heat produced by meteoric collisions.

Prof. G. H. Darwin, the eminent Cambridge professor, has proved mathematically one point in favor of Lockyer's hypothesis, He shows that the conception of fluid pressure required by Laplace's nebular hypothesis, and which is applicable to a gas, is also applicable to a swarm of meteorites. The pressure exerted by a gas against the surface of an inclosing vessel is supposed to be the result of collisions between the component molecules of the gas, and Prof. Darwin shows that, if we supposed these molecules magnified up to the size of meteorites, their collisions will still give a *quasi*-fluid pressure, and that the law of gases will be applicable to a swarm of meteorites. One objection may be raised to this view, namely, that the ultimate molecules of a gas are supposed to be perfectly, or at least highly, elastic, while meteoric stones have very little elasticity. Prof. Darwin, however, points out that, when the meteorites come into collision, the heat generated by the shock volatilizes a portion of each, so that the result will be like that of an explosive, and consequently there will be nearly perfect elasticity. He finds, further, that the analogy with the theory of gases will hold good for the meteoric swarms from which the solar system—on Lockyer's hypothesis—is supposed to have been evolved, a swarm extending beyond the orbit of Neptune. He also finds that the swarm when widely diffused will be subject to gaseous viscosity, and will first rotate as a solid body, but when more contracted "the central portion will revolve more rapidly than the outside."

With reference to the origin of comets, Mr. Monck inclines to the opinion that some comets, at least, originated "within the limits of the solar system," and to this class he is disposed to assign "the four comets which have been connected with meteor swarms." He argues that *some* meteors may be of terrestrial origin, and suggests that possibly Lockyer's experiments may have been made with some of these terrestrial meteorites.

There seems to be another weak point in Prof. Lockyer's hypothesis, and that is that it offers no explanation of how the planets and satellites of the solar system were evolved. This has been pointed out by Mr. Monck. He says: "Will any advocate of the meteoric theory give us an explanation of why all the planets and asteroids and the great majority of the satellites revolve in the same direction, why the orbits of the larger bodies of the system deviate so little from the circle, and why they are so nearly in the same plane? Till this is done I think the nebular hypothesis has in this case the advantage." A violent grazing collision between two dense meteoric swarms might, however, conceivably, be supposed to produce a rotation in the swarms, which would give rise to the observed planetary motions.

Another objection raised by Mr. Monck is, that it seems difficult to understand how the requisite number of collisions in a meteoric swarm could be produced and kept up, and "that meteor clouds dense enough to produce the requisite amount of light by their collisions would also be dense enough to intercept a great part of it again on its way to the earth." Mr. Monck's papers on the subject were published in the Journal of the Liverpool Astronomical Society.

Here the matter rests at present. It will be seen that hitherto the weight of evidence seems against the truth of Lockyer's hypothesis, but further researches on the subject will be looked forward to with considerable interest.—*Gentleman's Magazine.*

OUR AGRICULTURAL EXPERIMENT STATIONS.

By Prof. CHARLES LATHROP PARSONS.

WHEN, in 1851, a small local society of German farmers at Möckern, Saxony, realizing that scientific investigation could help solve the many obscure problems of their life, contributed from their own resources and asked their Government for aid to establish an experiment station to study such problems, a new epoch was begun in the history of agriculture. The idea that scientific research could be of use in studying and solving the questions related to the farm was by no means a new one. The educated proprietors of Europe were even then beginning to reap the proceeds of chemistry applied to agriculture. The work of Chaptal, Davy, Sprengel, and De Saussure, in the earlier part of the century, had been continued, supplemented, broadened, and enlarged by the great chemist Liebig, whose Chemistry in its Application to Agriculture and Physiology had opened the eyes of many well-known scientists, and given to intelligent farmers a new and brilliant field of labor.

In 1834 Mr. John Bennet Lawes, since knighted in reward for his labors, began experiments upon fertilization on a small scale. He gradually increased them until 1843, when he associated with himself the now celebrated chemist, Dr. J. H. Gilbert, and from that time he dates the establishment of the Rothamstead Experiment Station. Almost coexistent with the first work of Lawes in England, Boussingault began the study of plant physiology and nutrition on his farm and in his private laboratory in Alsatia. Many schools and universities already had zealous workers in this field, and numerous agricultural societies had their more or less active chemists.

But the epoch begun at Möckern in 1851 was new. The work which had been already accomplished had been so brilliant, so practical, so helpful, that when the society at Möckern established the first German experiment station, and secured government aid for it, the scientific German mind became fully aroused. It needed but two years of its valuable work to demonstrate its usefulness, and in 1853 the good example set by the Möckern farmers was followed by those of Chemnitz, also in Saxony.

From this time on agricultural experiment stations have multiplied so rapidly in Europe that it has been almost impossible to keep statistical pace with their growth. In 1856 there were five, in 1866 there were thirty, in 1873 there were sixty-three, while to-day there are one hundred and ten in France and Germany alone.

Fortunately for American farmers, a young American of exceptional intellectual abilities, reared in an agricultural community, and full of interest and zeal for his chosen profession of chemistry, went to Germany in 1853 to finish his studies at the University of Leipsic. Although Samuel W. Johnson had chosen scientific pursuits, he had by no means lost his interest in rural life, and, when led by chance or accident within so short a distance of the new station at Möckern, he at once became imbued with its life and spirit. The career of Samuel W. Johnson, now Professor of Agricultural Chemistry in the Sheffield Scientific School, and Director of the Connecticut Agricultural Experiment Station, was begun, and a fame was started which, gradually increasing with his investigations and published works, has reached a height in agricultural science which many will strive to reach in vain. He must always be considered the pioneer of America in science applied to agriculture. Fortunately, also, another young man, whose chief fault was in being born a few years later than his teacher, went to take a post-graduate course under Prof. Johnson, at New Haven. Receiving his doctor's degree in 1869, Wilbur O. Atwater went to Germany and there made a special study of the then largely increased number of experiment stations.

In 1872 the question had been discussed at a convention held in Washington, but on the 17th of December, 1873, the first direct effort to start an agricultural experiment station on this continent was made. Dr. Atwater on that day read a paper before an assembly of Connecticut farmers, in which he strongly advocated the establishment of such a station. His remarks were supplemented by Prof. Johnson; and, although the idea was new to most of those present, their arguments were so clear and convincing that a committee of eight was appointed to try and secure an appropriation from their Legislature for the purpose. The Connecticut Legislature, however, was composed mainly of farmers, and, strange as it may seem, the prejudice and sneers against "book farming" has caused by far the larger number of like bills to fail in such bodies whenever they have appeared. So it was here, although numerous petitions had been circulated about the State and very generally signed. The following winter also much hard work was done to arouse public sentiment in favor of the project; but still the next Legislature, although confronted by an increased number of petitions, could not be prevailed upon to pass the appropriation of $8,000 a year which was asked.

At this juncture Mr. Orange Judd, who had been an enthusiastic believer in the good of such an organization, came forward and offered the use of the laboratories of Wesleyan University, on behalf of the trustees of that institution, and $1,000 on his own part, provided the Legislature would appropriate $2,800 a year, for two years, to help pay the necessary expenses. The matter being brought in this light to the Legislature, it immediately passed the necessary bill, and the first American experiment station was established, October 1, 1875, at Middletown, with Dr. W. O. Atwater, who had been an indefatigible worker for the cause, and to whom the chief credit for the station's establishment is undoubtedley due, as its first director.

The work accomplished in those first two years—accomplished under such disadvantages that only a specialist can realize them—was so helpful to the Connecticut farmers that they could but acknowledge its benefits and provide for its continuance. When the two years were ended, the annual appropriation was increased to $5,000; and the Sheffield Scientific School having offered accommodations, the experiment station was reorganized at New Haven, with Prof. Johnson in charge. Three years later the appropriation was again increased to $8,000 yearly, and a special grant of $25,000 was made to permanently establish it on land and in buildings of its own.

The experiment station thus begun has saved thousands of dollars to Connecticut. Even in the first few years of its existence it was so apparent, and could so easily be shown, that the station was yearly saving several times its cost, that it was impossible for it to remain in obscurity, even if such had been its desire. Its fame soon spread beyond the limits of its own State, and numerous deputations were received from others who desired to examine into its workings. In 1876 California followed the example of the Middletown Station. In 1877 the North Carolina Station was organized. The Cornell University Station came next; then New Jersey, New York at Geneva; Ohio, Tennessee, Massachusetts, and others; so that, when the Hatch act of March 2, 1887, passed Congress, seventeen had been organized in fourteen States.

The so-called Hatch act gave a new and great impetus to the work of experiment stations in this country. It could not have been otherwise, for it made provision for an appropriation of $15,-000 a year to each State or Territory that would accept the trust, to establish a station in connection with its agricultural college, or to aid such stations already established. All of the States, except Montana, Washington, and Idaho, have taken advantage of the act, as have also New Mexico, Arizona, and Utah. Some have more than one, and some who have only one regular experiment station have organized one or more branch stations located in different sections of the State. If these branch stations be excluded, there are now fifty-three experiment stations in the United States; while, if they be counted, there are sixty-nine.

Congress saw fit to leave the government of the stations which it established to the various States in connection with their agricultural colleges, whose trustees generally have it in charge, and as a whole, or through properly authorized committees, engage specialists to carry on the work. The scientists thus engaged necessarily vary in their specialties with the lines of research which each particular station desires to undertake. The study of agriculture is a complex one, and there is scarcely a branch of science which is not called upon to take its part in the common advancement. A director is generally the first officer chosen. He is supposed to be a man well versed in the past literature of the subject, well known in his special branch of study, and of good executive ability. In the older stations this office is generally held by a chemist of long experience in agricultural experimentation. This is the case in the Massachusetts Station, where the work of Director Charles A. Goessmann has been of incalculable benefit to the agriculture of his State. This is also true of both Connecticut Stations, of the New York Station at Geneva, of the California Station, the Pennsylvania Station, the North Carolina Station, and others. At present, perhaps in the larger number of cases, the director's office is held by an experienced agriculturist, known for his ability to apply the results of previous scientific research to his particular branch. Besides a director, there are usually one or more chemists, an agriculturist, a horticulturist, and a botanist. Entomologists, veterinarians, meteorologists, biologists, microscopists, physicists, mycologists, viticulturists, geologists, etc., follow numerically in the order in which they are mentioned, and receive their appointment according to the several needs of the stations by which they are engaged. In all there are now four hundred and twenty-three persons employed in these stations, whose names are published as on the station staffs.

Although the experiment stations were left entirely independent of each other and any central head by the Hatch act, so that they have perfect freedom in their actions so long as they adhere to the purpose of the law, still Congress very wisely established a central office, under the Department of Agriculture, to collect and publish summaries of station work and thought in condensed and popular form for the use of the public; to publish special bulletins for experiment-station workers; digests of station reports; monographs, etc., and in general to serve as a medium of information and exchange.

A movement which in fifteen years increased the number of regularly organized experiment stations in our own country from one to fifty; whose influence has extended to Canada, South America, Australia, and Japan, causing the establishment of similar stations in those countries; which this year will expend approximately $1,000,000 in the United States alone, exclusive of the work of the Department of Agriculture; which during the year will send bulletins direct to nearly 400,000 farmers; and whose workings have been kept, in the main, free from politics must have had a worthy object, efficient workers, and given practical and useful results. That such is the case none familiar with the investigations of at least the older stations can deny.

The science of agriculture must always be the mother of its art, and to aid the art through the study of the science agricultural experiment stations were established. They were started to conduct experiments upon plants and animals and the needs of both; to improve the useful ones and eradicate the harmful; to study their nutrition in all its phases and determine the chemical composition of their foods; to learn how to cure their diseases, and promote their health; and besides increasing their productiveness and the quality of their products by proper food and care, to also introduce new and valuable ones from other localities. They were intended to study fertilizers and fertilization; the vitality and germination of seed; the variability of soils and waters; rainfall and general climatic conditions; and other questions influencing rural economy. But this was not all, for their chief aim was to distribute information, and to help educate the occupants of our farms and plantations, giving new aims, zest, and ambition to their too often humdrum life. In short, the United States experiment stations aim to help the American farmer in mind and pocket.

The greatest obstacle which the stations have met has been a demand by the farmers for immediate results and a prejudice against the laboratory and its work; but this gradually disappears as the farmers become more and more familiar with science. On this account the older stations are undoubtedly doing better work to-day than those of more recent origin, which are still struggling against this sentiment. Experience has taught, not only in Germany but here, that thoroughly scientific investigation invariably gives the most practical final result. As a rule, the older stations also have the most experienced and best-known agricultural scientists in their employ; but this is not always the case. With the large increase in the number of experiment stations which took place in 1887–'88 came a corresponding demand for the services of these experienced men, and several accepted more lucrative positions than they had previously held.

The demand for experienced men was, however, far in excess of the supply. From seventeen the number of experiment stations suddenly increased to fifty, with nothing like a proportional increase in men who were capable at the outset of filling the places to which they were appointed. At first, many places were undoubtedly filled by popular favorites, appointed to their positions through the influence of farmers' organizations or for wholly local reasons. Some of these have proved worthy of the trust and by hard study and work are building up their departments and themselves.

But the lack of suitable men has not been the only drawback to the work of the younger stations. Two clauses in the act passed by Congress allowing only three thousand dollars of the first and seven hundred and fifty dollars of each succeeding appropriation to be used for buildings and requiring that from the very first at least four bulletins a year be issued, while ultimately it may prove of advantage to them, has certainly tended at first to bring them no praise. It was supposed that the States would furnish buildings, but unfortunately some of them furnished either inadequate ones or none at all, and in one or two instances even the annual appropriation which the State had previously given to the agricultural college was abolished. The fact that quarterly bulletins were required by law, whether the station had valuable matter on hand or not, coupled with the fact that in many instances men wholly new to the business had to write them, tended at first to distribute more or less matter of questionable value. As the bulletins have general circulation among the class for which they were intended only in the State in which they were issued, many States necessarily sent out some compilations on the same topics which, to all practical purposes, were duplicates of each other. Bulletins, too, had to be written in popular style, in order that they might be understood by men whose education, in too many instances, had been limited to the winter district school. If it be also remembered that these newly formed stations have been organized scarcely three years and have not been in working order for that length of time; that they are going through the same trials as the older stations have had; that they have to break down the prejudices of many farmers, as the older stations have largely done; and that they were popularly expected to show in a few months results equal to those which even the German experiment stations have conquered only after years of strict application with the aid of the best of the scientists of that scientific nation—it can not be wondered at that these new-born stations have in several instances fallen short of what was expected of them. While in some cases the three-year-old stations may not as yet be able to show results equivalent to the $45,000 received by them in that time, still, as a whole, I think, no intelligent agriculturist familiar with their workings will deny that they have more than returned the appropriations received by them. In fact, I doubt if the increased value of commercial fertilizers, to improve which the stations were first established in this country, has not in itself more than balanced the account.

But while the younger stations are asked for immediate results to meet the popular demand, it must not be supposed that these results are all worthless or hastily compiled. To the contrary, they have profited by the example of the older stations, and many most excellent showings can be made, while many of the bulletins, compiled in some instances from work done at other places, on the scientific principle of stock-feeding, fertilization, and other topics, have been issued as an educating medium, and to familiarize the farmers with unavoidable technical terms and expressions.

While there is scarcely a science that has not been called into play in some one of the experiment stations, still, chemistry has its place in all and is pre-eminent in most. Horticulture, botany, and entomology are of course extremely prominent, while the study of fungi and bacteria is steadily increasing. But to review the present work of the various stations nothing better than the following summary, from an official report of recent date, can be given: "Twenty-seven stations are studying problems relating to meteorology and climatic conditions. Thirty-one are studying the soil, by investigations of its geology, physics, or chemistry; experiments in tillage, drainage, or irrigation; soil tests with fertilizers, or other experimental inquiries. Thirty-five are making analyses of commercial or home-made fertilizers, or are conducting field experiments with fertilizers. Thirty-nine are studying the more important crops with reference to the methods of culture, manuring, and rotations; varieties adapted to different localities and purposes; and chemical composition and nutritive value. Twenty-five stations are investigating the composition of feeding-stuffs, and in some instances making digestion experiments. Seventeen are dealing with questions relating to silos and silage. Twenty-four are conducting feeding experiments for milk, beef, mutton, or pork, or are studying different methods of feeding. Eighteen are investigating subjects related to dairying, including the chemistry of milk, bacteria of milk, creaming, butter-making, and the construction and management of creameries. At least thirty-three stations are studying methods of chemical analysis. Botanical studies occupy more or less of the attention of thirty-three stations; these include investigations in systematic and physiological botany, mycology with special reference to the diseases of plants, the testing of seeds with reference to their vitality and purity, and classification of weeds, and methods for their eradication. Thirty-five work to a greater or less extent in horticulture, testing varieties of vegetables and fruits, and making studies in varietal improvement and synonymy. Nine have begun operations in forestry. Twenty-five investigate injurious insects, with a view to their prevention or destruction. Fifteen give attention to veterinary science. At least four are experimenting in apiculture and three in aviculture. Sugar-making is experimented with at six stations, but the Louisiana Sugar Experiment Station does far more in this direction than any other." Thus it will be seen that the work is quite varied and comprehensive.

The work is progressive and is progressing rapidly. As the workers gain new knowledge and experience they gain new ambition to excel and aid the advancement of their particular branch of science by opening to it a new field for development. This field is a grand one; few have more or more interesting problems to solve or offer more for their solution.

In the fifteen years during which experiment stations have existed in the United States much advancement has been made in the art of agriculture and much money saved to our farmers. While the stations can not claim sole credit for this progress, they can claim a good share of the praise, and can show many broad and useful results of their work. It is next to impossible to enumerate these results, to show their full application, or even to give examples which will do them justice. Still, a few of general applicability may perhaps be cited with interest.

The chief argument raised in favor of the establishment of the first station in Connecticut was the fact that a few analyses of commercial fertilizers, made in the laboratories of the Sheffield Scientific School, had revealed, beyond a doubt, that immense frauds were being perpetrated in their sale upon the farmers of the State. The fact that crops responded so well to a really good fertilizer, and that it could be easily imitated by a worthless article whose uselessness was only made apparent by chemical analysis or crop failure, made these frauds easy and frequent. When the station was established the improvement of existing fertilizers and exposure of frauds was made its first duty. Before buying a fertilizer, any Connecticut farmer could have it analyzed free of charge, and its ingredients in valuable plant-food were thus previously made known. The station itself sent agents around the State and procured samples of fertilizers offered for sale, which were also analyzed. Excellent fertilizers were found, others little better than good surface soil; but the price of all was too much in excess of their valuation, or, in other words, the crude materials from which the fertilizers were mixed could have been bought by the farmers for much less than the fertilizers themselves. Finally, the analyses were published, with the poor ones and frauds fearlessly assailed, and the best ones pointed out. The result was inevitable. Honest fertilizer manufacturers co-operated with the station. Other States than Connecticut passed the necessary laws, took up the same work, found the same conditions and eradicated them; so that to-day the average cost of fertilizers exceeds their valuation barely enough to pay for mixing, while frauds have almost totally disappeared. When we consider that hundreds of thousands of tons of commercial fertilizers, averaging at least thirty dollars per ton, are annually applied to our soils, we can scarcely overestimate the value of this one line of work. The Director of the New York Station, Dr. Peter Collier, calculated in 1888 that the effect of twenty years of fertilizer control had been an average saving of 61·43 per cent in the cost of the three constituents of plant-food which are liable to be deficient in soils. The German experiment stations have had very similar experience.

It has long been known that no single plant furnishes the kind and amount of nutriment to give the best results with animals when fed to them, and farmers have used varying combinations of greater or less value for years. The German experiment stations took up, among their earlier investigations, the determination of the basis upon which the efficiency of these combinations rested, and after years of study it was found that it was due in the main to the relation existing between the digestible nitrogenous and non-nitrogenous constituents of the food; that the ratio between these ought to vary according to the purposes for which the animal was fed; and the amount of digestible nitrogenous and non-nitrogenous food which was necessary for the various purposes was determined. The tables thus given to the world by German investigation have been found to not wholly agree with our conditions, but they have been of invaluable service in applying the sound principle which underlies them to American stock-feeding; and it has been an important part of the work of our experiment stations to adapt them to our somewhat different needs. A large amount of success has attended their efforts, and, while the principle of feeding, according to the chemical composition of the food, can not as yet be said to be of anything like general application in the United States, still it is quite widely used, with greater or less success. For the more important purposes for which animals are fed, our ordinary plants, with the exception of some of the leguminosæ, contain too little nitrogen, and it has been found necessary to supplement them with other more highly nitrogenous foods. This need has served to utilize a number of by-products, as gluten, linseed, and cotton-seed meals, whose value is becoming more and more widely recognized. It has been one of the chief aims of our experiment stations, in extending the scientific principles of feeding, to develop the rational use of these foods, while numbers of farmers with their aid have largely increased their annual products.

One of the great problems which met our agricultural scientists was to arrange some way in which milk could be equitably bought and sold. As the amount of fat in pure milk may vary anywhere from less than three to over eight per cent, it is evident that the value of milk for butter-making must depend upon the amount of butter-fat that it contains. Any chemist can tell us this, but dairies and creameries can not afford to keep their chemists; so it became important to discover some method by which the amount of fat in milk could be quickly and accurately ascertained. For a number of years the attempt proved a failure, for the methods proposed were misleading. As the improved breeds of cattle became more prominent, it became more evident that great unfairness was done in paying a definite price per quart for milk without reference to its quality, and renewed and successful efforts were made by the various experiment stations to obtain some accurate chemical method which could be operated by any dairyman of ordinary intelligence. As a result of the effort, several good methods have been published within the last two years, and one or another of them has come into quite extended use. With the recent greatly increased supply of dairy products came the invariable reduction of prices, and the margin for gain has become so small that only the best cattle can be kept with profit. This fact makes the methods for the determination of the fat contents of milk unusually important, for by their use dairymen can weed out their poorer animals and by careful selection greatly enhance the value of their herds.

The improvements in the methods of extracting sugar from cane in Louisiana; the introduction of the process of "Pasteurization" of wines in California, which does away with the use of antiseptics of any kind; and many other useful results, either wholly or partly due to the experiment stations, might be detailed to advantage. None of them, however, compare with the great improvement among the American farmers themselves. The bulletins of the stations have done and are doing a good work. New facts, new theories, and new interests are daily added to the farmers' lives. A great school is open to them, of whatever age or sex, and they are learning. They are studying science upon their farms; observing insects, inquiring into the reason of blights and rusts, noticing the effect of different constituents of plant-food upon their crops; helping on their neighbors in the work; and are forming societies, and holding institutes, where they are discussing the scientific and economic problems of their lives with ever-increasing ardor and intelligence. Accustomed from their boyhood to drudgery, from their manhood to labor through all the hours of daylight, they have made a living and, with few exceptions, nothing more. A brighter future, however, lies before them. Our unoccupied arable lands will soon be exhausted, and population is ever on the increase. The farmers will co-operate more and more with our experiment stations, will find more and more beauty in their surroundings and with increased facilities and increased knowledge will take the place which belongs to them in our government and in our nation.

A COMING SOLUTION OF THE CURRENCY QUESTION.

By CHARLES S. ASHLEY.

IT is obvious that the present agitation for the free and unlimited coinage of silver derives its real strength mainly from a general feeling that the cheapening of the standard dollar would make it easier to pay off existing debts.

The great farmer class of the central States have seen their farms shrink in value fifty per cent in ten years—have seen the value of the annual product steadily falling; and in thousands of cases have found a purchase-money mortgage, after being half paid off, still equal to the selling value of the farm. It is natural and inevitable that the causes of this calamity should be largely attributed to the classes who have during the same period been growing steadily richer, and that the great agricultural class should turn to a cheaper currency as a remedy for debts harder to pay.

This is no new phenomenon. English kings, centuries back, when encumbered with debt, solved their difficulties by the easy method of paying their creditors with half the amount of precious metal they had agreed to pay—merely going through the formality of stamping the half by the same name as the whole had formerly borne. Thus the English pound sterling, like the French *livre*, is said originally to have been a pound weight (troy) of pure silver. Now it is equal to less than half that amount. Bluff King Hal the Eighth put two parts alloy to one part of silver into his coins, instead of one part alloy to twelve of silver, as had been and is now the rule. Anything to get the better of the Jew money-lend-ers was "all right." French, German, and other nations, including the Greeks and Romans, have had a similar and generally far worse history of their coinage.

While it must be admitted that the question of silver coinage, involving as it does the whole history of the production, use, and value of the precious metals, is a great and delicate and difficult problem, I believe there is no controversy about this proposition: that men should pay precisely what they contract to pay—should do just as they agree. The difficulty arises over the question as to what they really agree to do. If they agree to pay one hundred dollars, the question arises, What is a dollar? and the answer must be, in general terms, that it is a monetary unit, composed of a certain amount of gold or silver determined and defined by the United States Government. This leaves open the door for all sorts of honest differences of opinion as to what a dollar really is (since two kinds of dollars are in actual circulation), and also for a very wide field of action for the political power. Manifestly, if contracts were made to deliver a certain amount of gold or silver bullion, or a certain amount of wheat or railroad stock, of specified kind, the ambiguity would not arise.

This is the solution of the currency problem that the financial world, led purely by that enlightened self-interest which is at the bottom of most improvements, is preparing. Several copies of railroad mortgages, made within the last ten years from forms dictated at the great financial centers, lie before me, and in each of them I find the promise to pay "in gold coin of the United States of America of the present standard weight and fineness." For example:

The Toledo, Ann Arbor and North Michigan Railway Company . . . delivers "its certain ten thousand bonds for one thousand dollars each, . . . severally payable to the Farmers' Loan and Trust Company, or bearer, *in gold coin of the United States of America of the present standard weight and fineness* . . . with interest thereon . . . at the rate of five per centum per annum, payable *in like gold coin*."

No doubt there are hundreds of such mortgages, amounting in the aggregate to at least a billion dollars, and probably much more.*

The highest court of the land has several times declared that such contracts must be performed literally. If a man promises to pay a certain amount of gold, he must do so, whether at the time

* It is not easy to see how many of these companies could escape bankruptcy in the event of the free coinage of silver, if they were compelled to fulfill their contracts to pay in gold coin. While their earnings might rise somewhat from higher charges, it is hardly possible that they could earn thirty-three per cent more in that way—setting aside the likelihood of financial panic and business stagnation.

of payment gold be worth more or less. In Bronson *vs.* Rodes, 7 Wall., 229, Chief-Justice Chase said: "It is the appropriate function of the courts to enforce contracts according to the lawful understanding of the parties. . . . The intent of the parties is clear. . . . A contract to pay a certain number of dollars in gold or silver is therefore in legal import nothing else than an agreement to deliver a certain weight of standard gold, to be ascertained by a count of coins, each of which is certified to contain a definite proportion of that weight. It is not distinguishable, as we think, from a contract to deliver an equal amount of bullion of equal fineness." The same doctrine has been established by the cases of Butler *vs.* Horwitz, 7 Wall., 259, and Tribelock *vs.* Wilson, 12 Wall., 687, the latter case being decided in 1871, Justices Miller and Bradley dissenting. The later case of Gregory *vs.* Morris, 6 Otto, 619, decided in 1877, without dissent among the justices, affirmed the case first cited. And while it is within the bounds of possibility that this doctrine may be upset in some period of great excitement, it is as solidly established as any doctrine can well be, having been affirmed by a large number of the Supreme Courts of the States as well as by the Supreme Court of the United States, which in such matters has supreme authority.*

The currency problem has therefore been taken out of politics in a very large class of cases, and it can readily be done in nearly all. If bankers agree to pay their depositors in coin of a specified kind, say in gold coin of the present standard weight and fineness, regardless of legislation, they can readily make obligations due themselves likewise payable. Bankers, indeed, being subject to demand payments by their depositors, are really under a pledge to pay them in an undepreciated currency, since in the event of a debasement of the coinage the public would at once rush for the more valuable currency; and, as few bankers could stand such runs if made simultaneously on different banks, they are almost unanimously opposed to any change in the currency. The assertion may be ventured that the same causes that have led to the insertion of the above-cited provision in railroad mortgages will lead to similar contracts in other instances, particularly in the case of long-time, low-rate real-estate mortgages to insurance companies. While such changes can not come quickly, the pressure of interest and the universal desire for certainty will lead gradually to the adoption of expedients of the kind mentioned. If this kind of obligations should become common and of recognized validity, it is obvious that the political pressure, now so great, would be entirely neutralized, because few would have anything to gain

* For a collection of authorities, see 2 Daniel on Negotiable Instruments, sec. 1247.

from a debasement or enhancement of the value of the coined dollar.

If the conception of money as a commodity of convenient exchange should altogether supplant that of an artificial standard of value made by Congress out of its own will, the function of the Government would manifestly be reduced to certifying the weight and quality of precious metal in its coins. If it undertook nothing more than this (except the prohibition of coins not issued by itself), there would be nothing to prevent the free coinage of gold and silver, though a slight charge for the expense of coinage would be proper. And with practically free coinage for both metals it is submitted that the varying needs of the country for currency would be more perfectly met than in any other way, because with every "squeeze" in the money market bullion could at once be converted into coin, and *vice versa*. This, indeed, is already provided by section 3518 of the Revised Statutes, which says that the owner of gold or silver may have the same cast into bars with a stamp designating the weight and fineness thereof; but this statute, though no doubt of great use in facilitating the international exchange of bullion, is without the benefit it might have because the bars are not issued in sizes convenient for currency. It is the word "dollar" in existing contracts of indebtedness that prevents this; and if by such action as that above mentioned the word dollar shall be established as the present gold dollar, there would be nothing to prevent a healthy expansion of the currency by the free coinage of silver and the issuance of certificates for the same in any amount desired.

It would be an unspeakable blessing to have the currency question removed from the domain of politics. Questions of so complex a character are precisely those which the people are most ill qualified to decide. It is the interest of all that as few questions as possible having great financial importance should be decided by the political power; for therein lies the source of the corruption of the Government, the oppression of the people, the uncertainty of business, the possibility of panics, a stimulus of class-prejudice and class-greed, and the obstruction of legitimate public business.

*Mr. Warner.**—Corporation after corporation, savings-bank after savings-bank, life-insurance company after life-insurance company, have, since the passage of this last act, felt, not that they wanted anything to happen, but compelled, out of due regard for those whose money they were trustees for, to require that in all reinvestments and loans there shall be put a gold clause. That has actually taken place to such an extent that I believe that,

* Hon. John De Witt Warner, before Congressional Committee, February 16, 1891.

before the time Congress meets in December, in the great money centers this movement will have become general on account of this proposed legislation.

Mr. Bartine.—Do you know whether, after the passage of the former act, contracts were made payable in gold?

Mr. Warner.—Yes, sir; a good many were. . . .

SCIENTIFIC DREAMS OF THE PAST.

By ALBERT DE ROCHAS.

MANY of the inventions which are the glory of our time were foreseen by certain dreamers, in whose imaginations they received a kind of virtual existence. The electric telegraph is foreshadowed by Strada in some twenty verses of his Prolusiones academicæ, which were published in Rome in 1617. To him it was a fancy, a simple wish:

> "O! utinam haec ratio scribendi prodeat usu
> Cantior et citior properaret epistola!"

The manner in which he understood the instrument was reproduced by all the students of the time, notably by a Jesuit of Lorraine, Père Leurechon, in his Hilaria mathematica, published in 1624. I quote a passage, in which it is mentioned, from the French translation published two years later at Pont à Mousson, under the title of Récréations mathématiques, by an author who signed himself Van Etten:

"There are some who have intimated that absent persons might be able to converse by means of a magnet or some similar stone. For example, Claude being in Paris and John in Rome, if each had a needle rubbed on some stone the property of which was such that as one of the needles moved in Paris the other would move in Rome, it might be that Claude and John would both have a common alphabet, and that if they had agreed to speak from a distance every day at six o'clock in the evening, arranging that the needle should make three turns and a half as a signal that it was Claude and no other that wished to speak to John. Then Claude, wishing to tell him that the king is in Paris (*le roy est à Paris*), will move his needle and stop it at L, then at E, and then at R, O, Y, and so on with the others. At the same time, John's needle, acting in correspondence with Claude's, will move and stop at the same letters so that it will be easy for it to write and make understood what the other means." "The invention is very nice," Père Leurechon remarks, "but I do not believe there is a magnet in the world that has such virtues."

Phonography is thus described in the April number, 1632, of the Courier Vèritable, a little monthly publication in which novel fancies were frequently aired: "Captain Vosterloch has returned from his voyage to the southern lands which he started on two years and a half ago, by order of the States-General. He tells us among other things that in passing through a strait below Magellan's, he landed in a country where Nature has furnished men with a kind of sponges which hold sounds and articulations as our sponges hold liquids. So, when they wish to dispatch a message to a distance, they speak to one of the sponges, and then send it to their friends. They, receiving the sponges, take them up gently and press out the words that have been spoken into them, and learn this by admirable means all that their correspondents desire them to know."

Cyrano de Bergerac, in his Histoire comique des États et Empires de la Lune, whose first edition is dated as early as 1650, is still more precise. He relates that the genius that guided him to our satellite gave him for his entertainment some of the books of the country. These books are inclosed in boxes. "On opening the box I found inside a concern of metal, something like one of our watches, full of curious little springs and minute machinery. It was really a book, but a wonderful book that has no leaves or letters; a book, for the understanding of which the eyes are of no use—only the ears are necessary. When any one wishes to read, he winds up the machine with its great number of nerves of all kinds, and turns the pointer to the chapter he wishes to hear, when there come out, as if from the mouth of a man or of an instrument of music, the distinct and various sounds which serve the Great Lunarians as the expression of language." A few pages before this, Cyrano speaks of transparent globes, that serve for lighting, in which a non-heating lamp has been placed.

We are next told about microbes: "Figure the universe as a great animal; the stars that are worlds as other great animals which serve as worlds to other people like us, our horses, etc., and that we, in our turn, are like worlds in respect to certain animals still incomparably smaller than we, as are certain worms, fleas, and flesh-worms; that these are the earth to others still more imperceptible; and that just as we appear, each individual of us, a great world to these little people, it may be also that our flesh and our blood are only a tissue of little animals which maintain themselves, lend us motion by theirs and let themselves be led blindly by our will which serves them as a coachman, lead us in our turn, and produce altogether the action which we call life. Does not the itch prove what I am saying? Is the worm that causes it anything but one of these little animals which has deprived itself of civil society to constitute itself a tyrant of its country? That blister and that scab, of which you do not know the cause, have to come, either by the corruption of the enemies which these little giants have slain, or by the plague produced by the remnants of the food with which the disturbers have gorged themselves, and left in heaps of dead bodies on the field; or because the tyrant, after having driven from around himself his companions which were corking with their bodies the pores of ours, has given passage to the humor, which has become corrupt after having been ejected from the sphere of the circulation of our blood. For a further proof of this universal parasitism, you have only to consider how the blood runs to the spot where you are wounded. The doctors tell you that it is guided by Provident Nature, which desires to succor the debilitated parts; which would make us conclude that besides the soul and mind there is in us a third intellectual substance having its functions and organs apart. But for this reason I find it more probable to say that these little animals, feeling themselves attacked, send to their neighbors for aid, and they having come from all around, and the country being incapable of supporting so many people, they die of hunger, or are smothered by the pressure. This mortality takes place when the imposthume is ripe; for the corrupted flesh then becomes insensible in testimony that the animals have been smothered; and that the bleeding which we order to divert the inflammation is because that, having lost much by the opening which these little animals tried to cork up, they refused to assist their allies because they were hardly able to take care of themselves."

Cyrano tried to go up to the moon by tying around his waist bottles full of dew, which, according to the opinion then received, was attracted by the sun. He was not able to rise so high; but, after breaking a considerable number of bottles, he pretended almost to nullify the weight of his body, so that he could travel by long leaps, only grazing the earth, as many people fancy in their sleep that they are doing. "He reached the moon by means of a machine which he does not describe, and found there another terrestrian who had raised himself up by the aid of a Montgolfier and a parachute. He filled two large vessels with smoke, sealed them hermetically, and fastened them under his arms; the smoke, which tended to rise and could not penetrate the metal, immediately pushed the vessels up, and they carried the man with them. . . . When he had risen to the moon, . . . he promptly untied the vessels which he had bound as wings to his shoulders, and did it with such success that he had just reached the lunar air, four toises above the moon, when he took leave of his flippers. The elevation was still great enough for him to have been considerably hurt, if the wind had not inflated the voluminous folds of his robe, and gently sustained him till he set foot on the ground."

In 1760 another dreamer, Tiphaigne de La Roche, published under the title of Giphantie, an anagram of his name, a curious little work in which photography is described—in the ultimate state to which it has just been brought—with the reproduction of the colors. Tiphaigne supposes himself transported to the palace of the elementary genii, the chief of whom told him: "You know that the rays of light, reflected from different bodies, form a picture and depict those bodies on all smooth surfaces, like the retina of the eye, water, and ice. The elementary spirits have endeavored to fix those transient images; they have composed a very subtle and viscous matter, quick in drying and hardening, by means of which a picture is made in a wink. They wash a piece of cloth with this matter, and present it to the objects which they desire to depict. The first effect of the varnished cloth is that of a mirror, in which one can see all the bodies, near and distant, of which the light can bring the image. The cloth with its viscous coating holds the images, which the glass can not do. The mirror represents the objects faithfully to you, but retains none; our cloths represent them no less faithfully, but keep them all. The impression of the images is made the instant the cloth receives them. It is taken away at once, and put in a dark place; an hour later, the coating has dried, and you have a picture, all the more precious because no art can imitate the truthfulness of it, and time can not damage it in any way. We take from the purest source, the body of light, the colors which painters extract from different materials, and which time never fails to change. The precision of the design, the variety of the expression, the touches of more or less strength, the gradation of shades, the rules of perspective, are all abandoned to Nature, which, with a sure course that is never false to itself, traces on our cloths the images which are imposed by her on our eyes, and cause us to question whether what we call realities are not other kinds of phantoms imposed upon our sight, hearing, touch, and all the senses at once. The elementary spirit then went into physical details; first on the nature of the adhesive substance which intercepts and holds the rays; then on the difficulties met in preparing and using it; and, lastly, on the part played by light and the dried substance; three problems which I propose to the physicists of our time, and leave to their sagacity."

The function given by Tiphaigne to the elementary spirits suggests that that author had been initiated into the occult sciences, according to which all the substances in nature possess a proper life, a kind of mortal soul, defined by the term elemental, which directs their reciprocal actions.

"There is not a thing in the world, not a blade of grass, over which a spirit does not reign," says the Cabala of the Jews;

"their life has not an eternal principle as its center; at their death, all is at an end with them." According to Paracelsus, "All the elements have a soul and are living. . . . They are not inferior to man, but they differ from him in not having an immortal soul. They are the powers of Nature—that is, it is they that do what we usually attribute to Nature. We may call them beings, but they are not of the race of Adam." A similar doctrine is developed in Madame Blavatsky's Isis Unveiled. The same method of conceiving of the production of physical phenomena has had defenders in the world of positive science, as in the doctrine of monads of Leibnitz; in the anatomical elements of Claude Bernard, who speaks of our bodies as being composed of millions, milliards of minute beings or living individuals of different species, of which those of the same species unite to constitute our tissues, while the tissues join to constitute our organs, and all react upon one another with a harmonious concurrence for a common end;* and in Sir John Herschel, who wrote in the Fortnightly Review, in 1865, that all that has been attributed to atoms, their loves and hates, their attractions and repulsions, according to the primitive laws of their being, becomes intelligible only when we admit the presence of a mental quality in them. Modern scientific theories tend to assume the unity of matter, of a protyle, which forms all substances by different degrees of condensation. Some go still further, and assume that there is no matter in the ordinary sense of the word, but only force and energy. F. Hartman argues that we can change force into matter, and that is what takes place every instant in the human body, as well as in the vegetable and animal world, and we can change matter into force under like conditions. This etheric force, the base of all the others, is what Lord Lytton describes in his romance, The Future Race, as "vril." So these dreams are repeated—to receive, perhaps, possible verifications in future discoveries; and thus old follies may, as Beaumarchais says, in the Marriage of Figaro, become wisdom, "and the fictions of the ancients be transformed into pretty little truths."—*Translated for The Popular Science Monthly from the Revue Scientifique.*

According to calculations by M. L. Niesten, all the asteroids known (now more than 300), if combined into one, would form a body not quite 514 miles in diameter, or less than one twentieth the diameter of the earth; and it would require 8,575 bodies like it to form a planet having the volume of the earth. The largest of the asteroids, Vesta, is 230 miles in diameter, and the smallest, Agatha, four miles and a half. As all of these bodies having considerable size have most probably been discovered, the estimate of the mass of the whole is not likely to be materially affected by the detection of new ones.

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* Revue des Deux Mondes, September 1, 1864.

THE COLORS OF LETTERS.

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD, JUNIOR, UNIVERSITY.

THERE are certain powers possessed by childhood, which grow weak or disappear with advancing age or wisdom, until at last all recollection of them is lost. One of these is the ability to recognize shades of color in ideas or objects which can have no color at all. Now and then some trace of this power persists through life, and even in connection with some degree of maturity of judgment. It is then looked upon as a mild hallucination, provoking a smile of sympathy or of incredulity, but not regarded by the person himself—still less by his friends—as possessing any value or significance.

Nevertheless, such associations have a degree of psychological interest. A chapter has been devoted to them in Francis Galton's admirable work, Inquiries into Human Faculty; an interesting essay on Word Color has also been very recently published by Prof. Edward Spencer, of Moore's Hill College.* As a supplement to Galton's work, and as a contribution toward the more exact knowledge of the associations in the human mind of color with conceptions with which the idea of color is incongruous, the present paper is written. And as what I have to say is in a large degree subjective, partaking of the nature of a confession, the use of the first person may be pardoned.

In my youth I always associated the idea of color with the letters of the alphabet. In later years the discovery that other people recognized no such coloration came to me as a surprise. The letter R, for example, always calls up the idea of greenness. It is impossible for me to think of R without the thought that it is green. In like manner S is yellow, and X scarlet. The coloration does not seem to lie in the letter itself, as printed or written, but to coexist with the conception which the letter represents. As the letter R comes into my mind, it seems to go, with grass and leaves, into the category of green things. The sound has nothing to do with its apparent coloration, for C soft and C hard are recognized as the same letter and therefore colored alike. The coloration is not affected by the character of the type. It is in the letter itself, regardless of the way in which it may be printed, or of whether it is printed or written at all. The idea has no connection with the lettering in any colored picture books, nor does it arise from any association of that sort.

* Proceedings of the Indiana College Association for 1889, pp. 40–45, published December, 1890.

Words seem to me also more or less definitely colored, but the association of coloration with me arises solely from the letters of which the words are composed. The dominant letters, especially the initial letter, or the letters most conspicuous in pronunciation, give color to the word. Thus Rosalind, though containing but two green letters, has a dominant shade of green, as salvia or silica have of yellow. A pleasing variety in the colors of the letter tends to render a word attractive. Thus the words Vernon, Severn, and Exeter, with contrasted colors, are more attractive than such words as Patton, Hammond, or Armenia, in which the colors are few or not contrasted. This association of color is stronger than that of the names of the colors themselves, for these fail with me instantly to call up the colors they represent. Thus the word red seems decidedly green in its hue, and it seems unnatural to me that so many words beginning with R, as red, roth, rouge, ruber, rufus, and the like, should have come to mean red. The word blue is also largely green, while yellow is very far from the hue indicated by its meaning.

These letter colors seem for the most part not deep or vivid, but suggest transparent shades like the hues of colored stars, and they are often evanescent where the attention is fastened directly on them. The red, for example, is more like that of the planet Mars than that of a flaming torch. The shades of red vary somewhat, from the scarlet of X or Z, in which the colors seem most pronounced, to the reddish brown of *a* or *n*, in which the coloration is less conspicuous.

On the basis of these colors I would make the following classification of the alphabet, placing in each category the most positively colored letters first:

Red,	X, Z, F, E, H, A, N.
Green,	R, L, B, T.
Blue,	V, D, Y, K, W, M, P, Q; the V of a violet shade, the M and P lead-color, the Q almost colorless.
Yellow,	S.
White,	O, C.
Straw-color,	G, U.
Blue-black,	I.

In some cases, as in O, C, G, U, I, J, this supposed coloration is plainly derived from the forms of the letters themselves, the O inclosing most empty space, the I none at all. In some other cases, as E, F, or R, B, W, M, the resemblances of form in the pairs in question may have led to their taking place in the same category, the duller letter taking its place beside the brighter one which it resembles.

Similar associations take place with the numerals, although to me the coloration of figures seems less vivid than that of letters.

1 and 0 (zero) agree with I and O, 2 is red, 3, 6, and 9 more or less greenish, 4 and 5 bluish, following the letter V, 7 orange, and 8 light yellow. I have also tried the Greek alphabet, with a view to testing its possible color associations. I find, however, that I can not separate these letters from their Latin cognates. Theta seems to me as greenish as tau; chi (X) vacillates between C and X, and psi (ψ) is like the ps of which it is composed.

I have also made attempts to find the color relations in the Chinese alphabet, but without much success. I have no childish associations with these letters, and I can imagine color only in those which in some way suggest by their form the letters in the Latin alphabet. Thus 木 (tree) seems greenish like T, and 女 (woman) seems to follow Z or X.

I find that with other persons who confess to similar color associations there is a decided lack of agreement as to the impressions produced by most of the different letters.

My friend, Prof. Edward Spencer, has given me a chromatic alphabet, arranged as follows:

Shining black,	I, E, H, R, T, 1, 3, 4, 6, 7, 9.	Chocolate,	G.
		Light gray,	O, N, X, 5.
Dull black,	F, J, K.	Pale,	D, Z, V.
Brown,	B, M, Q, W.	White,	O.
Golden,	C, 8.	Water-color,	U, Y.
Orange,	S.	Without color,	L, P.

In this category the letters for the most part represent gradations from jet-black to white. We may, however, trace some relation between the supposed colors and either the forms or the sounds of the letters. Except in the color of the vowels I, O, U, and the isolated and emphatic position of S, there is little in common with the list above given by me.

In my own case, although I have no recollections to justify the theory, I feel sure that these associations are due to the bringing together of a childish classification of letters, with childish categories of color. I was, more than most children, interested in the individuality of the letters. I liked to assort them, to play with them, and transpose them to form other words. In like manner I was interested in colors. I had a childish liking for blue above the other colors, as also a meaningless preference for V and D over the other letters. I can, therefore, see how V and D should be associated with blueness. Other letters of pronounced qualities, as R, L, X, Z, came to head other categories, and the letters which I regarded as indifferent took their places next to those which in form or sound or otherwise appeared to the child similar to these.

Dr. Gustaf Karsten, of the University of Indiana, a philologist interested from boyhood in phonetics, recognizes color in the various vowel sounds, but none in the letters themselves. Thus *a* (in *ah*) is the most sharply colored—a burning red—and *o* (in *go*) is of a deep blue. These colors Dr. Karsten associates with the use of these vowels as interjections, *ah* having the red hue of interest or surprise, O the blue shade of pity or regret; *a* (in *may*) is greenish, *a* (in *cat*) is yellow, in *law* dark brown; *e* (in *tree*) is white, *i* (in *in*) is grayish, *o* (in *on*) dull violet, *oo* is black, and *u* dusky grayish.

A lady of my acquaintance recognizes color associations only with certain proper names. Thus, with her, Cæsar is crimson, Theodore blue, Lillian white, Mary or May yellow, Ethel and its compounds lavender, Edith heliotrope. Only names of some marked quality seem to have any color at all. Thus John, James, and the like are without this attribute.

In his article on Word Color, already mentioned, Prof. Edward Spencer has given an interesting account of his own associations of color with words. The substance of his observations he has kindly condensed in a letter to me, from which I quote as follows, adding to it two or three suggestive paragraphs from his paper on Word Color:

"It is natural that the first assertion of the experience of double impressions should have been received with incredulity. I have vainly tried for years to find ears attentive to what I honestly believed a real and reasonable experience, and it is now a great satisfaction to me to see the remarkable growth of interest in this class of subjects.

"My own experience with this class of phenomena has been almost entirely confined to the observation of shade and color as being inseparably connected with characters and words. Word color was first observed by me at the age of six years. At the time it suddenly flashed upon my mind that stone was light in color and the word 'rock' was darker, each one quite nearly resembling the color of the article to which the name was applied. Soon after this time the Arabic figure 8 appeared a beautiful golden yellow. Next, when beginning the study of Greek, the letter θ (*theta*) appeared the color of pearl. Since then shade and color have manifested themselves in an ever-increasing list of characters and words, until they are now perceived in most of the letters and in all parts of speech in all the languages with which I have any acquaintance.

"All suggest to the mind an appearance of shade: some being very light; others dark, and others medium. Color is less often distinguished, but when seen it is even clearer than is the degree of shade. Beginning with one color—yellow, seen in 'rock'—the list has slowly increased until it now includes cream, pearl, black, gray, golden brown, orange, light blue, light and dark brown. The last mentioned was first noticed while writing these pages.

"Thought and reason seem to give but little assistance in determining the character of any word. It is, however, noticeable that the more attention that is given to the subject in general, the clearer do all words shine out. These shades and colors are permanent. A word or symbol seems to have a peculiar and individual character which never changes.

"A student of mine, Mr. C. E. Mead, of Ramelton, who had never before heard of the subject, has spent some time examining me and recording the results.

"If one should wish to divide all visible objects into classes on a basis of the lightness or darkness of their shades of color, he would find some manifestly very light, almost white; others very dark, almost black; others would be of intermediate shades. Let him call all that are very light, 1; all that are very dark, 5; then 2, 3, and 4 would indicate intermediate shades. Some objects would easily be seen to belong to certain classes. Others, even with the aid of contemporaneous examination, would be very difficult to locate. It is convenient to divide words into classes upon the same basis, indicating their degrees of shade by numbers, letting 1 represent very light words, 5 very dark ones, and 2, 3, and 4 the intermediate shades.

"A newspaper article containing fifty words was taken, and a number representing the degree of shade was assigned to each. After two weeks, Mr. Mead returned to me the same list of words, and numbers were reassigned. Out of the list, instead of ten, which the law of chance would indicate would be the same, thirty-four were identical. In no case was there a variation of more than one degree. For example, no word which bore number three in the first test was given number one in the last, nor *vice versa*. Colors were assigned to twenty-one out of forty names and characters. Two weeks later the same colors were reassigned to all but one.

"I do not know how these distinctions are made. I am not conscious of obtaining them by application of any rules or principles. When a word is presented, it is felt to be light or dark, black or yellow, and the mind declares it to be such with little thought or delay, and apparently in the same manner as the pitch and quality of musical sounds are judged.

"My own experience has been so vivid and persistent that I could not doubt that there were reason and law as the basis of the matter. Yet I could not and did not expect that a theory of word-color would be able to find credence as the result of my single testimony.

"Whether or not there is any significance in the fact, nearly all who perceive color in words have made the first discovery in early childhood.

"Various theories have been suggested: the association of the emotions with the words which arouse them, the form of the characters, the sound of the pronunciation of the characters or words, the nature of the mechanical production of the sounds.

"I believe that the fairest conclusion of the matter is, that color and shade depend chiefly upon form, but that sound and sense may have some influence. That there is some relation, some analogy which warrants the statement that this word is light and that is dark, I can doubt but little more than that it is appropriate to say that one sound is high, another low.

"Can it be that this association of form and color is an arbitrary product of the imagination? I would believe it myself but for three facts: The phenomena were observed at an age apparently too early for the origination of any such strange and elaborate idea; too early for the development of any theory universally applicable to all words and letters; too early for the dreams of the imagination to remain as the realities of later life. Second, I do not know nor remember of ever having laid down any principles of criticism. Third, I am not conscious of employing any such principles. To do this would require great use of the memory. I have no reason for believing that it is so employed. Indeed, rather than burdening the memory with special facts or general principles, word-color even relieves it of a part of its proper work. It has more than once assisted in the study and use of ancient language vocabularies. For example, only by means of this have I been able to distinguish between *ferus*, fierce, and *ferrum*, iron. When wishing to refer to the place of the former use of a word, its shade is of great service in finding its position on the page. Sometimes by its assistance words are seen to be correctly or incorrectly spelled. How many are there of you who do not write in two ways a word of doubtful spelling, and then choose one for no other reason than that it 'looks right'? Such an act is, perhaps, an unconscious testimony to word-color."

Associations of color with musical tones are not uncommon. Certain musicians claim to play the piano by color. One of my correspondents is positive that there exist definite relations between color and sound. In his view "every person has a key-note, and each key-note corresponds to a color which the person naturally prefers to any other." He claims to be able to indicate a "person's favorite color by knowing this key-note. A fine piece of music may thus be worked into a painting by using the colors corresponding to the musical notes." Conversely I should suppose the colors of the rainbow might be rendered into a musical symphony of perfect harmony.

Not less curious is the occasional association of color with taste. A student tells me that when she was a young girl she frequently recognized colors in the taste of various articles of food. Sometimes she would say to her mother that this food—otherwise agreeable—"tastes so very yellow that I can not eat it." She was reproached for such eccentric notions, and finally outgrew them. Now she is unable to recall any of these associations, or to remember what substances formerly tasted yellow, and what ones blue or green.

I may close this discussion with a wise observation of Francis Galton: "Persons who have color associations," he says, "are unsparingly critical. To ordinary individuals one of these accounts seems just as wild and lunatic as another, but when the account of one seer is submitted to another seer, who is sure to see the colors in a different way, the latter is scandalized and almost angry at the heresy of the former."

ANIMAL AND PLANT LORE.

By Mrs. FANNY D. BERGEN.

IV.

ACCORDING to popular tradition, a surprising variety of physical ailments or discomforts may be relieved by human saliva, used in compliance with certain explicit rules. Such prescriptions abound both in our own day and in the pseudo-medical literature of earlier ages, varying more or less in different places and in different periods, but here and there to-day we find some interesting survival that tallies exactly with a superstition two thousand or more years old.* Many of these popular prescriptions apparently are based entirely upon supposed curative virtues of human saliva, while others may more properly be said to be directions for working, by means of spittle, spells or charms, that are supposed to cure bodily disorders.

So general do I find to be the belief that human saliva has medical properties, that, desiring to be on the safe side before ranking as out-and-out superstitions many very common customs dependent upon this belief, I have consulted a number of trustworthy medical authorities in regard to the matter. The universal testimony is to the effect that there is not the slightest scientific warrant for any prescriptions in which relief of pain is promised on account of any specific remedial quality of spittle. Warmth and moisture may be grateful to a burn, insect-bite, or

* The present paper, which deals almost entirely with the uses of saliva in folk medicine, forms only a part of a somewhat extended treatment of the subject of American superstitions in regard to saliva which the writer hopes, at some future time, to present in a more permanent form in connection with other folk lore.

otherwise inflamed surface of the cuticle, but warm water would always do all that saliva could do.

One very queer notion which I have found in parts of Pennsylvania, northern Ohio, central Maine, and in Dorchester, Ontario, is that a pain or "stitch" in the side, induced by running or rapid walking, may be cured by lifting a stone, spitting on its under surface, and replacing it. In Chelsea, Mass., children who bring on pain in the side by running say that it may be cured by picking up a small pebble and placing it for a time under the tongue. In Cambridge, school-children in racing or in playing romping games may often be seen to stoop, pick up a pebble, and insert it either under the tongue or under the upper lip to prevent pain in the side. An eleven-year-old boy belonging to a cultivated family, and attending one of the best public schools in Cambridge, assures me that he believes a person could run all day without weariness or pain by adopting this simple precaution. The above-mentioned charm-cures become more interesting when compared with two Swabian beliefs recorded by Dr. Buck. One of these is that palpitation of the heart may be relieved by secretly lifting a stone from the ground, spitting on it three times, and replacing it; while a Swabian cure for toothache is to have the sufferer spit on the under side of a silicious stone.

In eastern Massachusetts and in parts of New Hampshire a very common practice, when one's foot is "asleep," is to cross the top of the benumbed foot with the tip of the fore-finger moistened with saliva. An Italian fruit-vender tells me that this usage is very common among the peasant class in Italy. In Lawrence, Mass., the same thing is done to the hand if it be "asleep." From northern Ohio a variation of the practice is sent me: if the foot or leg be "asleep," to spit on your hand or finger and rub under the knee on the hamstring is said to give quick relief from the unpleasant pricking sensation. An Irish servant-girl in Brooklyn, N. Y., recommended the same remedy. Among the people comprising a small Gaelic community on Cape Breton is found another variation of this remedy—the saliva-charm there used to relieve the discomfort of a foot "asleep" being, if the right foot is the one troubled, to wet the right fore-finger with spittle and rub the right eyebrow; if the left foot be "asleep," to moisten the left fore-finger and rub the left eyebrow. Pliny quotes from Salpe the statement that when any part of the body is "asleep" the numbness may be relieved by spitting into the lap or by touching the upper eyelid with spittle. Pliny also states that a "crick" in the neck may be cured by putting fasting spittle on the right knee with the right hand and on the left knee with the left hand.

The evident relationship between the last two old Roman cures and the Gaelic one above cited suggests an interesting problem for the student of comparative folk lore. Both the Roman and the Cape Breton charm cures may be descendants of some older Aryan superstition, or the Cape Breton one may have been brought to Great Britain by the Roman invaders. But what theory of distribution will account for a custom similar to those just cited, which is very general among the Japanese, a people separated from western Europeans by the whole width of an immense continent, and differing ethnically so far from the Caucasian race ?

It naturally happens, from the Japanese national custom of sitting with the feet doubled under on a mat, that one or both legs will become numb. A Japanese scientist has kindly communicated to me the following particulars in regard to the saliva cures for this numbness:

"In the province of Suwo (southwest part of the main island of Japan) a person picks up a piece of straw, wets it with saliva, and then sticks the same on the middle part of his forehead. The piece is left there till it naturally comes off. In Tokio, after a piece of straw is placed on the forehead, as in the above process, a person wets his index-finger, with which he first touches the tip of his nose and then he rapidly moves his finger up toward the forehead (without touching the latter or the straw). This is repeated three times, accompanied by a saying, 'Shibire Kyo ye agare,' which is of course also repeated the same number of times. The phrase means literally, 'Numbness, go up to Kyo.' Kyo is an abbreviation for Kyoto, where our emperors used to live for many centuries till 1868, and which was then the recognized center of Japan. People always spoke of going up to 'Kyoto.' I do not know the origin of the phrase addressed to the numbness, neither do I know its true significance; but one which strikes me as very probable is, that it was meant to entice numbness out of the lower members of the body, as every one was right glad to obey such a command at any time. In the province of Echigo (northwest part of the main island of Japan) I heard that straw is not used, but a cross is drawn on the forehead with a finger wet with saliva."

Since the cross is not one of the emblems of the old Shinto or of the Buddhist religion, the signature of the cross in the last charm is undoubtedly a survival from the introduction of Roman Catholicism into Japan by Jesuit missionaries in the sixteenth century.

Pliny states that a boil may be cured by wetting it three times with fasting spittle. We still find various kindred remedial charms extant in the United States. From a village near Portland, Maine, comes the notion that pimples may be removed by moistening with saliva. In central Maine I find the belief that ringworm may be "killed" by moistening the finger in the mouth and rubbing around the diseased spot, taking care to move the finger in the same direction in which the sun moves.

This is only one of many survivals which I have found, in our own time and country, of the old *withershins* superstition, of which I shall treat more fully in another place.

In County Kent, England, W. G. Black says, in his Folk Medicine, there is a belief that a wart may be removed by wetting the fore-finger with saliva and rubbing the wart in the same direction as a passing funeral, meantime repeating, "My wart goes with you." In eastern Massachusetts and in central New York I find the notion that warts may be removed by rubbing them with spittle. A working-woman from Boston tells me that if one rubs a corn with spit upon retiring, four nights in succession, the center will come out of the painful callosity.

We have all seen how involuntarily people moisten a slight burn with saliva. As above suggested, the application of moisture, and consequent evaporation, no doubt afford some relief to the pain of a burn, and if it be on the hand or wrist the quickest and easiest way to moisten the inflamed spot very likely may be to carry it to the mouth; but if the burn be on the arm, and a pail of water be at hand, or a faucet over a kitchen sink, it certainly can not be to save trouble that the finger is wet with saliva and the latter carried to the burn. And yet the latter process is often resorted to even by persons who disclaim any belief in charms or superstitious usages. A Worcestershire charm for a burn, quoted in Black's Folk Medicine, is to keep the burn a secret, spit on the finger, and press it behind the left ear. We frequently see bruises as well as burns treated with saliva. It is almost an instinctive act with many individuals instantly to raise a knuckle that has received a sharp blow to the mouth to moisten it with spittle. Or a mother or nurse often wets her finger with her own saliva and smears with it a bump on a child's head. This suggests an interesting custom found in parts of Japan, of which the Japanese gentleman, above quoted, has told me. "When a child hits his head against a hard object, he at once applies his own saliva on the painful spot to prevent a lump from being formed, repeating, 'This is parent's saliva, this is parent's saliva,' thus showing the reverent belief in the efficacy of his parent's saliva."

The application of saliva to sore or inflamed eyes is in accordance with a widely distributed superstition. I have myself known several persons in Massachusetts, of considerable education and great refinement, who faithfully resorted to this popular mode of treatment in slight ailments of the eye. In Woburn, Mass., the confervaceous vegetation, commonly found floating on the surface of pools and sluggish streams, and known by the vulgar name of "frog-spit," is used as an application for inflamed eyes, no doubt in the full belief that, as a kind of spittle, it possesses all the healing powers of that substance. I remember, when a child, in northern Ohio, hearing older people say that sore eyes could usually be cured by anointing them with spittle upon awakening for three mornings in succession. Among the Gaelic community on Cape Breton, above mentioned, I find that a popular cure either for a sty or for ophthalmia is to wet one or both eyes, as the case may be, for nine mornings in succession with fasting saliva. Dr. Buck reports that the Swabians also believe in the efficacy of fasting spittle for sore eyes; and our never-failing Pliny records the Roman belief that ophthalmia may be cured by anointing the eyes every morning with fasting spittle. From Black's Folk Medicine I quote: "Hilarion cured a (blind) woman in Egypt by spitting on her eyes. Vespasian so cured a blind man of Alexandria." Many other examples could be quoted to show the general occurrence of this mode of treatment of disorders of the eyes, both in earlier times and at the present day. It will be noticed that in a majority of the instances just mentioned it is *morning* or *fasting* spittle that is recommended to be used in order to accomplish a cure. A belief in the specific qualities of fasting spittle ranges far and wide. Besides the general recommendation of morning or fasting saliva for ophthalmia, Pliny states that the Romans generally considered that a woman's fasting spittle was highly efficacious for bloodshot eyes. If the woman had abstained from food and wine the day before, better results were to be expected. Scot, in the Discoverie of Witchcraft, records an accredited method "To heale the kings or queenes evill, or any other sorenesse in the throte: Let a virgine, fasting, laie hir hand on the sore and saie: Apollo denieth that the heate of the plague can increase where a naked virgine quenchith it, and spet three times upon it." Fasting spittle is popularly supposed to have both curative and poisonous properties. Black quotes the following from a correspondent: "Two old-fashioned ladies we know (they are Scotch, by the way) hold firmly to the belief that it is very hurtful to swallow the saliva that is in the mouth on first waking. They would not do it on any account." In Madagascar the first spittle in the morning is called "bitter or disagreeable" saliva, and it is thought to have medicinal virtue in healing diseases either of the ear or of the eye.

It is a very common habit throughout the United States and New Brunswick to moisten a mosquito-bite, a slight bee-sting, or the bite of a fly or other insect with saliva. Dr. Buck says that the Swabians also treat fly and bee stings with saliva, morning or fasting saliva being esteemed most efficacious. This popular mode of alleviating the pain caused by the injection of the usually acid secretion of insects is no doubt often made use of as being the easiest or most convenient way to moisten and cool the smart, and if the wound be instantly sucked with the lips, very likely the poison may be in part withdrawn and relief thus obtained; but I am convinced, as the result of a good many inquiries among people of various occupations and nationalities, that there is a popular belief that human saliva is effective in palliating irritating bites or stings of insects. It would not, perhaps, be easy to prove, but I strongly suspect that there is some historical relationship between our common custom of moistening such stings with saliva and an ancient belief that human saliva had power to antidote many animal poisons, and by its mere contact to destroy serpents and various other dreaded and repulsive creatures. A few superstitions that I have found show that this old belief still survives. In a previous paper I mentioned the New England notion that if a snake should spit into a person's mouth it would surely kill the latter; and now from Maine comes the converse of that superstition, viz., that if a human being spit into a snake's mouth the reptile will quickly die. Quaint old Sir Thomas Browne, in his Vulgar Errors, a book remarkable for the exposure of so many fallacies current in the age in which it was written, expresses a doubt, founded on experience, "as to whether the fasting spittle of man be poison unto Snakes and Vipers," thus showing that this was an old English belief. Pliny recommends fasting saliva as a preservative against the poison of serpents; and in another place he writes: "But the fact is that all men possess in their bodies a poison which acts upon serpents, and the human saliva, it is said, makes them take to flight as though they had been touched with boiling water. The same substance, it is said, destroys them the moment it enters their throat, and more particularly so if it should happen to be the saliva of a man who is fasting." Pliny cites Marcion of Smyrna as authority for the statement that the sea-scolopendra will burst asunder if spit upon, and that the same is true of frogs and "bramble-frogs." Human saliva is popularly believed by the Japanese of to-day to be a deadly poison to centipedes. W. G. Black says that Galen believed that a scorpion could be killed by a person's spitting. A gentleman whose childhood was spent near London, Canada, recalls a superstition of that neighborhood to the effect that if one should spit on a toad's back the creature would split open, precisely the same as the belief which Pliny quotes from Marcion, save that in the Canadian form of the fable the toad takes the place of the frog. In the same locality in Canada children held that if a toad should spit on a person warts would be the result, and this notion is to be met with in various parts of New England. This is only one of many outgrowths of the old superstition regarding the "venom" of the toad. The Swabian folk medicine, according to Dr. Buck, credits toad-spittle with being very poisonous, and mere contact with a toad is said to cause a limb to swell, especially if the animal has first been made angry. Levinus Lemnius speaks decidedly of the poisonous character of these really harmless creatures; but it is needless to multiply quotations to show how general has been the belief that toads and all pertaining to them were poisonous to man.

Occurring in great abundance in summer upon the young shoots of many plants, and especially upon the culms of grasses, the little flecks of froth in which are concealed the pupa of the frog-hoppers or spittle insects (*Cercopidæ*) are not popularly known to be the exudation of an insect, but are supposed to be the spittle of some animal, and hence the substance has received a variety of common names. I find the name "toad-spit" given to this exudation in eastern Massachusetts, parts of Maine and northern New Brunswick, and the same name is applied to it in parts of England and in the Isle of Jersey. In Jersey the old notion of the toad's venomous character obtains and its spittle is thought to be poisonous, "to poison the blood," as the peasants say; so of course the "toad-spit" upon the plants, being thought to be veritable saliva of toads, is avoided. A woman from Bathurst, New Brunswick, télls me that the so-called toad-spit is frequently found on wild strawberry plants, and the berry-pickers are careful not to gather any fruit on which is to be seen any of this much-feared pseudo-spittle, for, as she says, "you know the berries would be rank poison, for toads are very poisonous; they take all the poison out of whatever they touch. If they are in a well, they suck up all the poison out of the water, and so, when they spit, of course, this poison will be in their spit." In Reading, Mass., the exudation of the tiny creature, lurking unsuspected, within its frothy covering, is called either toad-spit or snake-spit, and bare-footed children fear to let it touch their feet, as the saying is that it will blister the skin. Snake-spit is the name applied to the excretion in many other localities in New England. In Ipswich, Mass., children say that if you make a wish and then break off a certain number—twenty-five, I believe—of grass-stalks without losing the snake-spit on any one of them, your wish will surely come true. In parts of the Maritime Provinces of Canada and in Staffordshire, England, frog-spit is another name for the foamy masses. When a child, in northern Ohio, I remember to have often seen the grasses along the roadside besprinkled with the spit-like substance. I never heard any one speak of it, and I carelessly concluded that it was blown upon the grass by passing horses that had the "slobbers," as the farmers there say. But I am told that on the north coast of Prince Edward's Island the name "horse-spit" is one in common use for the substance; frog-spit and cuckoo-spit are other synonyms in the same locality. This last fanciful name is also to be met with in England and Ireland. A native of County Kerry, Ireland, has told me in considerable detail the popular theory, in that region, of its origin. The cuckoo-spit, she said, is found only on the leaves of sorrel (*Rumex acetosella*). Any one who looks inside the little bunches of spit will find a very small green bug, and this bug is the last thing the cuckoo ate before she went away for the winter. So, when she comes back, she must spit this out before she can sing at all. And therefore, when people see this spit on the sorrel leaves in the morning, they say, "Now the cuckoo's come back again," or "The cuckoo's been here in the night."

Very generally throughout the United States the spittle of an angry dog, if introduced into the circulation, is thought to be a deadly poison, and the bite of a dog that is enraged is feared almost like that of one having hydrophobia. The same belief is held to a less extent regarding the saliva of an angry man. In Swabia, says Dr. Buck, not only are both of these kinds of spittle deemed to be highly poisonous, but the most dangerous of all is reckoned to be that of a person who has been tickled to death! Some interesting superstitions brought here by Irish immigrants, concerning the dangerous character of the spit of the weasel, have been recounted elsewhere.* With us the saliva of an angry horse is also dreaded. The saliva of the rat, both in the United States and in England, is pretty generally endowed by the popular imagination with venomous properties, whether the rat which inflicts the bite is especially irritated at the moment of biting or not. In the rat's case the poisonous character attributed to the bites of the long, chisel-shaped incisors is sometimes ascribed to a specific poison existent in the saliva, and sometimes to the teeth being covered, as it is thought, with the remains of the garbage on which the animal feeds. Frank Buckland, one of the best of authorities on such matters, asserts positively that the bite of the rat is not poisonous, and that bad effects follow from rat-bites only when the patient's system is in such a condition that any trivial wound might cause serious consequences.† Several skilled physicians, to whom I have addressed inquiries in regard to the nature of wounds inflicted by the teeth, either of man or of such domesticated mammals as are likely to attack man, have all stated that, contrary to the popular belief, these bites are no more dangerous than like injuries inflicted

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* Article III of this series.

† Curiosities of Natural History, popular edition, first series, fifth edition, pp. 107, 108.

by other weapons than the teeth. It is true that the bite of certain animals—a squirrel, for example—often suppurates and heals very slowly, but this is to be ascribed to the depth and laceration of the punctures inflicted by its powerful teeth, which are usually made to meet in the finger of the person bitten. Of course, in what precedes, it has been assumed that the animal which inflicted the bite was not rabid. There is a rather wide-spread belief among uneducated people that, if any one is bitten by a dog, the latter should at once be killed, lest at some future time he go mad, when the person bitten would also become rabid. This baseless fear seems also to be common in Ireland, according, to Lady Wilde.

Equally irrational with the general ascription of hurtful powers to mammalian saliva is the popular belief in its healing powers. Not only is it usual to hear people say that the dog, for instance, in licking his wounded paw, is making a most efficient vulnerary application, but the dog is encouraged to lick the hand of his master to cure a cut finger or other slight injury. No doubt the cleansing effect of constant licking would be most salutary and would promote healing by the first intention, but in the popular mind a specific healing virtue is attached to dogs' and to cats' saliva—a virtue which is, however, purely imaginary.

Would it be premature to suggest, as a provisional explanation of many saliva cures, especially those of a surgical character, that they are survivals of primeval surgery; and that this, in turn, had its origin in our inheritance from the lower animals, which so often apply saliva to wounds and ulcers by lapping them with the tongue?

But to trace in detail the genealogy of saliva cures and saliva charms is a task as yet impossible. It would surely not be easy even to show how the Mandingo negroes, the South Sea islanders, the American Indians, and the Japanese have come to share with the Aryan and Semitic races in beliefs concerning the magical efficacy of saliva.* For the solution of such problems as this the young science of folk lore must wait, on the one hand, for a general advance in the field of anthropology, and, on the other, for the accumulation and collation of data exceeding a hundred-fold those accessible to the folk-lore student of to-day.

DATA collected in Switzerland by Mlle. N. Iwanoff go to show that mortality from organic disease of the heart decreases as the altitude of the habitation rises. As a secondary result of the inquiry, it was found that this mortality is higher in towns than in the country.

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* Some details in regard to the geographical and ethnical distribution of certain saliva charms were given in a paper of mine, Some Saliva Charms, read before the American Folk-lore Society, at its Philadelphia meeting, November, 1889.

HÖFFDING'S OUTLINES OF PSYCHOLOGY.*

THE translation of Höffding's Psychology which is now offered to English readers is not from the original Danish, but from the German translation. Dr. Höffding has, however, taken a cordial interest in the preparation of the English edition, and accepts it as adequately representing the original. The work contains seven chapters, of which the first four are general and introductory. Chapter I, on the Subject and Method of Psychology, shows that the author is in close sympathy with the English school in making analysis precede synthetic speculation. And in this connection we noted with interest a marginal reference to another work of Prof. Höffding, that on The English Philosophy of our Times (Copenhagen, 1874; German translation, 1889). We have consequently given much heed to his occasional remarks upon the contrast between the German and English schools, of which we give the following as examples:

> The English school devotes attention rather to the elementary real side of conscious life, to the manner in which the mental structure is raised by the combination of fundamental elements; the German school, on the contrary, attends more to the connection and unity which from beginning to end are the marks of consciousness. . . . German psychology has often exhibited a tendency to approach metaphysics; English psychology, on the other hand, has approached the mechanical sciences, and has transferred analogies from them to the conception of mental phenomena.

Chapter II treats of Mind and Body; Chapter III, of the Conscious and Unconscious; Chapter IV is a short one on the Classification of the Psychological Elements; and the remainder of the volume contains three long chapters on the Psychology of Cognition, the Psychology of Feeling, and the Psychology of the Will. His evident familiarity with all the schools of philosophy and with the evolution of mental science in all times and countries gives a characteristic breadth and adequacy to his views upon disputed questions.

In his chapter upon Mind and Body Prof. Höffding discusses the relation between these two different provinces of experience. Using the word mind in the sense of consciousness—as a collective term for sensations, thoughts, feelings, and resolutions—he asks what experience teaches as to the connection of consciousness with that other province of experience whose content is what moves in space. His standpoint is purely *empirical* or *phenomenal*. He

* Outlines of Psychology. By Harold Höffding, Professor at the University of Copenhagen. Translated by Mary E. Lowndes. London and New York: Macmillan & Co., 1891. 375 pages, small octavo. Price, $1.50.

regards the subject from the psychological and not from the metaphysical point of view. It is with him a question of science rather than of philosophy, and this circumstance gives especial interest to his views. We have had abundant philosophical disquisition upon this subject, and it is refreshing to be told by a man of science just how the case stands as a matter of knowledge.

Although psychology is not a part of philosophy, yet Prof. Höffding teaches that philosophical thought, as a form of mental activity, lies within the sphere of its observation. Without making any assertions about the absolute nature of mental life, or whether such a nature exists, psychology can bring a knowledge of mental phenomena, of their mutual relations and their laws of development, as a contribution to the general conception of the universe; and such a conception, framed in accordance with experience, should be able to clear the point of view and to correct many prejudices.

In treating of the Interrelation of Mind and Body, Prof. Höffding accordingly examines briefly, but with care and penetration, the hypotheses that have been framed to explain the connection between conscious life and the life of the brain. He proceeds entirely from the point of view of experiential psychology, and with no reference to a final philosophy—believing that we only reach the metaphysical point of view when experience has been thoroughly explored and its tendencies have been determined.

We give the following extended extract from Prof. Höffding's work, both on account of its intrinsic interest and as an example of his style and mode of treating the subject. Allowing due weight to all the facts brought forward concerning the relations of mind and body, he says: "Only four possibilities can be conceived: (*a*) either consciousness and brain, mind and body, act one upon the other as two distinct beings or substances (dualism); (*b*) or mind is only a from or a product of the body (materialism); (*c*) or the body is only a form or a product of one or several mental beings (idealism or monistic spiritualism); (*d*) or, finally, mind and body, consciousness and brain, are evolved as different forms of expression of one and the same being." In examining these several possibilities Prof. Höffding repeats that, whichever we may prefer, we can adopt it only as a provisional hypothesis and not as a final philosophical or metaphysical theory; our only concern being to learn what is the view of experiential science.

He enters upon the subject of dualism by asking: "Does an excitation of a sense-organ, when transmitted to the brain, pass into sensation? Does our will set the body in motion? What is the relation between states of consciousness and brain processes? The ordinary notion is that the mind acts upon the body and the body upon the mind." He has elsewhere sagely remarked that the popular mode of apprehension is distinguished from the scientific in being a compound of experience and metaphysics, and we have here such an instance. But his own clear and guarded statement is as follows:

That we feel this immediately seems to be contradicted by the want of agreement as to the existence of a mind distinct from the body, and by the fact that it is only indirectly that we have come to know with which part of the body the mind is more particularly connected. We can not maintain that the bodily process causes the mental process, because the bodily process (the state of brain connected with sensation) does not itself become an object of consciousness. And if physiology could give a scientific explanation of the condition of the brain that ensues when I am struck by a stone, the feeling of pain aroused in me would not be included in the physiological explanation. Physiology explains a material process by means of other material processes. Its assumptions can not include a case in which one member of the causal relation shall be spatial and the other non-spatial.

Nor does the doctrine of the persistence of energy support the idea of a causal relation between the mental and material. "The doctrine of the persistence of energy is a purely *physical* doctrine. Such an extension would imply the possibility of finding a common measure for the mental and material. Now, what denominator is common to a thought and a material movement, or what common form serves for both? Until such a common form can be pointed out, all talk about an interaction between the mental and material is, from a scientific point of view, unjustified. So long as we confine ourselves to the material we are on safe ground, and so long as we confine ourselves to the mental we are on safe ground; but any attempt to represent a transition from physical to psychological laws, or conversely, brings us face to face with the inconceivable. The causal concept can not be employed to connect two factors which have no common measure. Again:

"If the relation between mind and body, or consciousness and brain, is a causal relation, there must be a difference of time between the process in the brain and the act of consciousness. This, however, is contrary to the view suggested by physiology. The aim of modern physiology is to conceive all organic processes as physical or chemical. Where it has attained to a comprehension of anything in the region of organic life, this has *in every case* been by the tracing back of organic phenomena to physical and chemical laws. If, then, there is a transition from physiological function to psychological activity, from body to mind, physiology, at any rate, working with its present method, can not discover it. . . . So far as we can speak of final results in the physiology of the brain, it is represented as a republic of nerve-centers, each with its function and all in interaction; but there is nothing to indicate the possibility of the physiological process breaking off at any point to pass into a process of a wholly different kind." But in framing our hypotheses we may not enter into conflict with leading scientific principles. "And, in modern natural science, the doctrine of energy is such a leading principle. If, therefore, an hypothesis is in conflict with such a doctrine, the fact tells at once decidedly against it."

Here follows a brief account of the doctrine of interaction as it appeared in the writings of Descartes, who, it is said, gave clear and distinct form to the current doctrine which helped greatly to lay bare its weak points. "To Descartes, therefore, belongs the credit of having set the problem of the relation of mind and body. For to the current notion in its vaguer form there is no difficulty in this relation. With legitimate heedlessness, the practical usage of speech ignores theoretical difficulties. Ordinary language no more regards the fact that physiology and psychology are opposed to the notion of brain and consciousness acting on one another than it respects the doubt of Copernicus as to the sun really moving round the earth. Moreover, the practical usage of speech has been formed under the influence of a partly spiritualistic, partly materialistic metaphysics."

Materialism.—The case is made clearer when one of these two factors is, without more ado, struck out.

And since the perception of the external material world takes the leading part in our ordinary ideas, while our inner self-consciousness is with difficulty educated to a like clearness and distinctness, it is perhaps the most natural thing to identify materiality with reality, and to conceive of the mental as an effect of the material. Modern materialism usually treats the mental as a function of the material. It has found a solid basis in the doctrine of the persistence of matter and energy and in that of physiological continuity. As a method of natural science it is unanswerable. But it is another affair when the method is converted into a system. It has a perfect right to treat all changes and functions of the organism, and in particular of the brain, as material; but it goes further when it maintains that the phenomena of consciousness are only changes and functions of the brain, and in this consists its encroachment.

Prof. Höffding alludes to the position of Carl Vogt, who in his time gave great offense by declaring that "as contraction is the function of muscles, and as the kidneys secrete urine, so, and in the same way, does the brain generate thoughts, movements, and feelings." In Vogt's comparison, "doubtless the chief emphasis is to be laid on the secreting activity and not on the product. The principle, however, remains the same. Among cautious physiologists with some philosophical training, the doctrine that conscious activity is a function of the brain may be sometimes met with." But the strict physiological use of the term function must contradict such a doctrine. To say that contraction is the function of the muscle, only means that it is a certain form and a certain condition of the muscle in movement. It is just as material when functioning as when at rest. The conception function (in the physiological sense) implies, just as much as the conception matter or product, something presented as an object of intuition in the form of space. But thought and feeling can not be pictured as objects in space, or as movements; we get to know them, not by external intuition but by self-perception and self-consciousness. That which has not the properties of the material can not be the form of activity of something which is material. Activity of consciousness and cerebral function always come to be known through different sources of experience. The encroachment of materialism consists in the fact that it effaces this essential distinction.

Materialism has never observed that, even if all its assertions are admitted to be just, it yet overlooks something which gives rise to a new and for it a terrible problem—namely, the circumstance that movement in space is known to us only as an object of our consciousness. For the theory of knowledge such notions as consciousness, idea, and intuition lie deeper than such notions as matter and movement. For this reason an absolute and decided materialism was possible only in ancient times, before the awakening of more deeply penetrating philosophical reflection. Democritus is the only consistent materialist. None of the modern materialistic writers can speak with the calm and the certainty with which Lucretius in his majestic verses sets forth the doctrine of Democritus. Modern materialists for the most part confess that, even if we can reduce everything to matter, yet we can not know what matter is in itself. Thus La Mettrie, Holbach, Cabanis, not to speak of the wild and rambling inconsistencies of the most recent writers (Büchner, Moleschott).

But the objection here urged against materialism is not its desire that conscious life shall accept as the only reality something which is given only as an object of consciousness, and can be represented only through the activity of consciousness; but rather that the facts impel us to the result that materialism offends against the conceptions derived from experience itself.

In treating of *monistic spiritualism* as the third possible hypothesis, we must always hold fast the distinction between an empirical and metaphysical way of looking at things. Very many confusions relative to the problem before us are the result of overlooking this distinction. Monistic spiritualism is the view according to which the mind is a mental (*geistige*) substance, and the mental is the only reality: everything material, all movement in space, is but an outer form of a mental life. It is based on the impossibility of explaining the mental by the material, and on the fact, partly overlooked, partly undervalued, by materialism, that our conception of matter is a mental product, and that apart from our conception of it we do not know what matter is. Thus the mental is a presupposition on which all thought rests; and a reasonable hypothesis is formed only by the reduction of the less known to the better known. The mental is properly the only thing fully intelligible to us, for in it we have not only a knowledge of outward circumstances and relations, but a knowledge also of the thing itself. . . .

But, supposing all this to be true, it is not to the point. For, if it be granted that everything is mental, and that nothing exists except thoughts and ideas, there still remains a distinction between ideas of material movement and ideas of phenomena of consciousness; and thus again arises the problem how these different sets of ideas, which have arisen in accordance with experience, are to be combined. The problem for psychology is empirical, and is independent of the metaphysical. We do not ask whether mind or matter is most fundamental; we inquire in what way menta' and material phenomena are connected in that experience which every system of metaphysics consciously or unconsciously presupposes.

The fourth possibility, the *identity* hypothesis, regards the mental and the material worlds as two manifestations of one and the same being, both given in experience.

If it is contrary to the doctrine of persistence of force to suppose a transition from the one province to the other, and if nevertheless the two provinces exist in our experience as distinct, then the two sets of phenomena must be unfolded simultaneously, each according to its own laws; so that for every phenomenon in the world of consciousness there is a corresponding phenomenon in the world of matter, and conversely. The parallels already drawn point directly to such a relation; and it would be an amazing accident if, while the characteristic marks repeated themselves in this way, there were not at the foundation an inner connection. Both the *parallelism* and *proportionality* between the activity of consciousness and cerebral activity point to an *identity* at bottom. The difference which remains in spite of the points of agreement compels us to suppose that one and the same principle has found its expression in a double form. We have no right to take mind and body for two beings in reciprocal interaction. We are, on the contrary, impelled to conceive *the material interaction* between the elements composing the brain and nervous system *as an outer form of the inner ideal unity of consciousness.* What we in our inner experience become conscious of as thought, feeling, and resolution, is thus represented in the material world by certain material processes of the brain, which as such are subject to the law of the persistence of energy, although this law can not be applied to the relation between cerebral and conscious processes. It is as though the same thing were said in two languages. . . .

In the mental as in the material world we hold fast the law of continuity. The *identity* hypothesis regards both these worlds as two manifestations of one and the same being, both given in experience.

The two languages in which the same thought is here expressed, we are not able to trace back to a common original language. So long as we keep strictly to experience, one province is presented as a fragment while the other extends to infinity. The doctrine of the persistence of energy makes the material world into a totality which we can never measure, but in which the fate of the individual forms and elements can be traced. The mental world has no corresponding law to exhibit. Mental elements come and go in experience without our being able to point to an equivalent. The fact that mental states can not be measured like physical energies and chemical substances is, in itself, sufficient to frustrate the hope of our finding a mental parallel to the doctrine of the persistence of force. But, in addition to this, even the fundamental conception of a mental existence puts difficulties in the way. Material existences can pass one into another, so that the energy lost in one is preserved in the other. The doctrine of the persistence of energy shows us the unity and eternity of Nature during the coming and going of all material beings; but mental existence, as has been seen, has for its fundamental form, memory, synthesis; and synthesis presupposes *individuality*. The material world shows us no real individualities; these are first known from the psychological standpoint, from which inner centers of memory, action, and endurance are discovered. If now we conceive of the individual mental elements (sensations, thoughts, feelings, etc.) as capable of being transposed to other combinations, like chemical atoms, it would follow that they might have an existence apart from a definite individual consciousness—a supposition which our account of consciousness shows to be absurd. Sensations, thoughts, and feelings are mental activities which can not persist when the definite individual connection in which they occur has come to an end. . . .

The theory to which we are here led is not a complete solution of the problem between mind and body. It is only an empirical formula, an indication of the manner in which the relation presents itself provisionally, when, following the hint of experience, we take heed of the close connection between the mental and the material, and the impossibility of a reduction of the one to the other, together with the difficulties attending the notion of a transition from the one to the other. Concerning the inner relation between mind and matter, we teach nothing; we suppose only that one being works in both. But what kind of being is this? Why has it a double form of manifestation; why does not one form suffice? These are questions that lie beyond the realm of our knowledge. Mind and matter appear to us as an irreducible quality, just as subject and object. We therefore postpone the consideration of the question, since it is evident that it lies in reality far deeper than has been usually supposed. But the empirical formula with which we conclude does not exclude a more comprehensive metaphysical hypothesis.

THE QUIANGANES OF LUZON.*

By Prof. F. BLUMENTRITT.

THE Quianganes of Luzon, Philippine Islands, live for the most part in small settlements in the mountain districts; but they have larger colonies in the more level regions, where they can cultivate rice. Their homes are all built after the same type, of wood or reeds, with wooden floors, about twelve feet square, resting about a yard above the earth on posts. They cultivate rice wherever the supply of water will permit it, and, as their land is rarely level, they lay it out in terraces, which they call *pilapil*. If the slope is moderate, they make them of earth; if steep, they strengthen them with walls of stone, the height of which is largely governed by the inclination. Having no plows, they till the soil by main strength with wooden shovels. The watering is very laborious, and sometimes, when in dry seasons the springs fail, their labor is lost. In consideration of the unending vigilance and work exacted by the rice crop, a high value is set upon it.

The men go out to the fields in groups of from six to twenty

* From the missionary report of the Dominican Père Villaverde.

persons, relatives or friends. They work a day for one, a second day for another, and so on, till each one is given his turn—the owner of the field cultivated for the day having to board the whole company. There are also day-laborers who work for the wealthy, and besides their board receive wages in chickens or rice. Their industry is not much developed. Their smiths make of iron axes, lance-heads, knives for cutting rice, and short wood-knives. Their best lance-heads and their *gansas*—a kind of guitar, mounted with bronze and copper—come from the valley of Japao. They make a flute of a reed, which they blow with their nostrils.

The Quianganes recognize the classes of nobles and plebeians. Nobility is a personal character and not hereditary. He is noble who is rich, and among these again those are most eminent who have distinguished themselves as head-hunters; for the Quianganes are a head-hunting tribe. But wealth alone is not sufficient to make any one noble; it is necessary also to go through a certain established ceremonial. The newly rich plebeian who would enter the aristocratic class notifies the people of his own and the neighboring villages of his intention, whereupon a general rejoicing prevails in anticipation of the feasting and drinking that are to come. The finest tree is selected from the wood and felled, and from it is hewn a figure that looks as much as anything else like an animal set erect, from which the legs have been cut off. All the guests work upon this figure, while they are entertained at the expense of the candidate for noble honors. When the statue is finished, it is left lying in the woods, and the company return to their homes. After the end of the field-work, the company go again to the woods for the statue, which is called *Tagabi*, to take it to the candidate's village; a task which is attended by numerous ceremonies. The train joins in a festal march, on which the host strews the road with rice. The transportation of the *Tagabi* is not accomplished in a single day, for the party all go back to their ranches after the first feast; and it is not till the third day that the ceremonial entry of the statue into the village takes place. The figure is deposited under the house of the candidate, and the grand feast follows by which he is received into the caste of the nobles; but to remain there only as long as he is wealthy: wherefore the nobles, to preserve the recognition of their rank, are obliged to give from time to time ocular demonstration of their ability to hold it, by feasting the plebeians and the poor. In this way they often fall into the hands of usurers; and they rarely keep their wealth together long enough to leave it, with its accompanying nobility, to their sons. The sons, nevertheless, even if they have become plebeians, believe that they are honored, and have a special pride in calling themselves sons of nobles.

Old people are greatly esteemed among the Quianganes, chiefly because they can serve as priests and have a special knowledge of religious doctrines and usages. In war, they readily follow the lead of the bravest. Women are highly respected, and, with children, are spared when blood feuds are prosecuted; for the vengeance of the Quianganes is executed only on grown men.

In marriage, the bride is bought from her uncle, or, if she has no uncle, from her brothers or cousins. On the death of his wife, or in case of divorce, the husband must return to her relatives the gifts he has received with her, and a buffalo in addition, especially if he intends to marry again. As he has also to make the usual presents to the relatives of his new bride, and is further expected to provide the wedding feast, a second marriage is a costly affair. Divorces are frequent. With the great irritability of the people, a harsh word is often enough, and the pair go apart. But there is usually a more serious cause than this. Children are spoiled. They are allowed to do as they please, and even to resist their parents, without correction. For a parent to chastise a child insures the condemnation of his tribesmen. In sharp contrast to this extreme neglect of their children is the mutual support of one another by adults. A personal assault demands unconditional blood-vengeance; a scornful word or gesture will not be borne. It is especially dangerous to excite their jealousy in the slightest degree. For this reason intercourse with them is not easy. They are themselves carefully on their guard against hurting the feelings of another, and demand that others shall do the same with them. Blood vengeance is a sacred law with the Quianganes. If one plebeian is killed by another, the matter is settled in a simple manner by killing the murderer or some one of his family who is likewise a plebeian. But if a prominent man or noble is killed by a plebeian, vengeance on the murderer, a mere plebeian, is not enough; the victim of the sin-offering must be an equivalent in rank. Another nobleman must fall for the murdered noble, for their doctrine is, What kind of an equivalent is it to kill some one who is no better than a dog? Hence the family of the slain noble looks around to see if it can not find a relative of the murderer to wreak vengeance upon, who is also a noble; while the murderer himself is ignored. If no noble can be found among his relatives, the family of the murdered man wait patiently till some one of them is received into the noble's caste; then the vendetta is prosecuted, although many years may have elapsed.

When the blood-feud is satisfied a reconciliation of the contending factions takes place. In all the feuds the heads of the murdered champions are cut off and taken home, and the head-hunters celebrate the affair festally. The skulls are fixed to the front of the house.

They believe that the souls of those who die a natural death go to a land called *Kadungayan*, or the northern region, where they dwell, all gathered in a wood in their special trees, which appear as trees in the daytime, but are changed at night into huts like those of the Quianganes; and that these souls have plantations of sweet potatoes and other food-plants, and live on the invisible substance (or souls) of the animals, rice, and other provisions which their friends left behind offer up for them. Those who have committed robbery and murder on earth without justification receive suitable punishment in *Kadungayan*. If a murderer dies a natural death, his soul is pierced in that shadow-land by a resident spirit.

The Quianganes believe that the souls of the departed sometimes return from *Kadungayan* to the members of their families. Bearing upon this is the following story: There once thus came a spirit with his wife to his people, who fed the pair with the finest rice-meal. When this became too expensive to the relatives, they seated the couple in a canoe and turned it toward the mountains of the Mayoyaos, where the spirits landed. The man sat down upon a stone under the shadow of a tree. A bird in the tree dropped some excrement on the head of the spirit, who did not move. There grew from this a great tree which gradually inclosed within itself the whole of the sitting Quiangane. This tree is called *balisé* (it is identical with the banyan); and the Quianganes still make their breech-cloths from its bark. The souls of men who die a violent or sudden death, and the souls of women who die in childbirth, go to the heaven of the gods. By this are meant the stars, particularly the sun.

The feasts of the dead are of two kinds, according as the deceased has died a natural or a violent death. In the former case the survivors spend all their means, and even go in debt, to procure a sufficient number of swine and buffaloes for the spirit, who will have to subsist in *Kadungayan* on the "substances" of the offered beasts. The unburied corpse remains, in a sitting position, underneath the house, for at least three days, while the exhibition is sometimes extended to fifteen days, and even more. The more wealthy and prominent the dead man had been, the longer the feasting and exhibition. But if the man has been killed or has fallen a victim to the head-hunter, only one pig is slaughtered, and it is eaten by the old men of the village. For they say, "Wherefore slaughter beasts, when the dwellers in the sky have no use for them?" Opposed to this is the precept that the substances of the animals which are consumed at the victory-feast of a returned head-hunter will come to the benefit of the souls of those whose heads he has cut off.

The Quianganes say that the souls of the dead do not go at once to their destination, but abide for some time near the house of death. They climb from rock to rock, and clamber from tree to tree, subsisting upon such stuff as they can gather up, and trying by night to get back into the house. They do this in order, if possible, to possess the person most closely connected with them, or his soul. Thus, for example, the deceased husband wants to take his wife, the wife her husband, the son his parents, etc., into the other world with him. They consequently believe that serious illness is caused by the efforts of a dead relative to entice the soul out of the body.

As soon as the doctor has come into the hut of the sick man a young hen is offered him, which he slaughters in honor of the venerable ruler of the death kingdom of *Kadungayan*. He examines the fowl's entrails and then pronounces his diagnosis, but not before he has made himself acquainted with the condition of the patient, saying something like this: "The soul of the patient, having looked upon his grandfather's (or his son's, etc.) soul, is at such a place. It is necessary, in order to bring him back, to slaughter so many swine and a buffalo," etc. At the same time he takes the guitar already spoken of and makes a terrible racket on it; then declares, "Behold the sick man's soul has taken leave of the soul of his dead grandfather" (or whatever relative it may be) "to return—it is already nearing the patient." If the patient has a turn for the worse, the medicine-man is called a second time, and declares that his soul has gone away again; that it is restrained by this or that spirit; that it seems to be already at home in the other life, or is about to unite with the spirit of the deceased relative. More pigs, more buffaloes, must be killed to move the soul to come back. Many well persons participate in the consumption of the sacrificed animals, and the sacrificing priest manages to convey the lion's share of the meat to his own house. The families of patients often become heavily indebted in consequence of these offerings.

The Quianganes believe in the reality of dreams, particularly if they relate to the life beyond. Thus a sick man told that he dreamed that his soul had gone up to the sky, where it had feasted itself and drunk to intoxication. The other souls, which lived in houses built in the Quiangane style, did the same. He also observed that Quianganes whose heads had been cut off in battle with the Mayoyaos had new heads, but very small ones. The pleasant belief prevails that the "substance" of the wine called *bubud* prepared by them is peculiarly enjoyed by the spirits and demons. The belief furnishes them with convenient excuses for indulgence. The occasions for the most profuse consumption of *bubud* are the beginning of field-work, when cattle according to the means of the farmer are also slaughtered, in cases of illness as described above, and on the return from a head-hunting expedition. On the last occasion the victor celebrates an imposing feast, at which many animals are slaughtered in honor, not of the victor, but of his victim, whose head, raised up on the point of a lance, is the center of the orgies. The "substance" of the viands consumed on the occasion and of the liquors is good for the soul of the beheaded man, and for that reason the head-hunter is put to the expense of the feast. For the same reason the vengeance-hunting relatives of the murdered man do not disturb the feast, although it would be easy for them to fall upon the stupefied participants and thus easily satisfy their vendetta. Other occasions are the beginning of the rice-harvest; the end of the harvest, when, all the crop having been gathered in, the principal festival occurs; on a special festival of general drunkenness; and as a protection against being struck by lightning—for lightning loves *bubud* beyond measure, and spares those who by their own intoxication consecrate much of the *bubud* substance to it.

The future is divined from the livers of animals. When they apprehend illness or danger from the lance of an enemy, before a journey, or when they hear a bird singing or see a rainbow while working in the field, they kill an animal, in order to ask its liver concerning the future. If the prognostication is unfavorable, another animal is killed, and another, and so on, till an animal is found with a lucky liver.

The Quianganes count on their fingers to ten, and repeat the operation as often as it is necessary. They also use a cord, in which they fix the number by knots. They count the years by harvests, the months by moons. They have no special names for the days of the week, and fix the time of day by the height of the sun.—*Translated for The Popular Science Monthly from Das Ausland.*

ON THE WINGS OF THE WIND.

OF course you know my friend the squirting cucumber. If you don't, that can be only because you've never looked in the right place to find him. On all waste ground outside most southern cities—Nice, Cannes, Florence; Rome, Algiers, Granada; Athens, Palermo, Tunis, where you will—the soil is thickly covered by dark, trailing vines which bear on their branches a queer, hairy, green fruit, much like a common cucumber at that early stage of its existence when we know it best in the commercial form of pickled gherkins. As long as you don't interfere with them, these hairy, green fruits do nothing out of the common in the way of personal aggressiveness. Like the model young lady of the books on etiquette, they don't speak unless they're spoken to. But if peradventure you chance to brush up against the plant accidentally, or you irritate it of set purpose with your foot or your cane, then, as Mr. Rider Haggard would say, "a strange thing happens": off jumps the little green fruit with a startling bounce, and scatters its juice and pulp and seeds explosively through a hole in the end where the stem joined on to it. The entire central part of the cucumber, in short (answering to the seeds and pulp of a ripe melon), squirt out elastically through the breach in the outer wall, leaving the hollow shell behind as a mere empty windbag.

Naturally, the squirting cucumber knows its own business best, and is not without sufficient reasons of its own for this strange and, to some extent, unmannerly behavior. By its queer trick of squirting, it manages to kill at least two birds with one stone. For, in the first place, the sudden elastic jump of the fruit frightens away browsing animals, such as goats and cattle. Those meditative ruminants are little accustomed to finding shrubs or plants take the aggressive against them; and when they see a fruit that quite literally flies in their faces of its own accord, they hesitate to attack the uncanny vine which bristles with such magical and almost miraculous defenses. Moreover, the juice of the squirting cucumber is bitter and nauseous, and if it gets into the eyes or nostrils of man or beast, it impresses itself on the memory by stinging like red pepper. So the trick of squirting serves in a double way as a protection to the plant against the attacks of herbivorous animals and other enemies.

But that's not all. Even when no enemy is near, the ripe fruits at last drop off of themselves, and scatter their seeds elastically in every direction. This they do simply in order to disseminate their kind in new and unoccupied spots, where the seedlings will root and find an opening in life for themselves. Observe, indeed, that the very word "disseminate" implies a general vague recognition of this principle of plant-life on the part of humanity. It means, etymologically, to scatter seed; and it points to the fact that everywhere in nature seeds are scattered broadcast, infinite pains being taken by the mother-plant for their general diffusion over wide areas of woodland, plain, or prairie.

Let us take as examples a single little set of instances, familiar to everybody, but far commoner in the world at large than the inhabitants of towns are at all aware of: I mean the winged seeds that fly about freely in the air by means of feathery hairs or gossamer, like thistledown and dandelion. Of these winged types we have many hundred varieties in England alone. All the willow-herbs, for example, have such feathery seeds (or rather fruits) to help them on their way through life; and one kind, the beautiful pink rose-bay, flies about so readily, and over such wide spaces of open country, that the plant is known to farmers in America as fireweed, because it always springs up at once over whole square miles of charred and smoking soil after every devastating forest fire. It travels fast, for it travels like Ariel. In much the same way, the colt'sfoot grows on all new English railway banks, because its winged seeds are wafted everywhere in myriads on the winds of March. All the willows and poplars have also winged seeds; so have the whole vast tribe of hawkweeds, groundsels, ragworts, thistles, fleabanes, cat's-ears, dandelions, and lettuces. Indeed, one may say roughly, there are very few plants of any size or importance in the economy of nature which don't deliberately provide, in one way or another, for the dispersal and dissemination of their fruits or seedlings.

Why is this? Why isn't the plant content just to let its grains or berries drop quietly on to the soil beneath, and there shift for themselves as best they may on their own resources?

The answer is a more profound one than you would at first imagine. Plants discovered the grand principle of the rotation of crops long before man did. The farmer now knows that if he sows wheat or turnips too many years running on the same plot, he "exhausts the soil," as we say—deprives it of certain special mineral or animal constituents needful for that particular crop, and makes the growth of the plant, therefore, feeble or even impossible. To avoid this misfortune, he lets the land lie fallow, or varies his crops from year to year according to a regular and deliberate cycle. Well, natural selection forced the same discovery upon the plants themselves long before the farmer had dreamed of its existence. For plants, being, in the strictest sense, "rooted to the spot," absolutely require that all their needs should be supplied quite locally. Hence, from the very beginning, those plants which scattered their seeds widest throve the best; while those which merely dropped them on the ground under their own shadow, and on soil exhausted by their own previous demands upon it, fared ill in the struggle for life against their more discursive competitors. The result has been that in the long run few species have survived, except those which in one way or another arranged beforehand for the dispersal of their seeds and fruits over fresh and unoccupied areas of plain or hillside.

I don't, of course, by any means intend to assert that seeds always do it by the simple device of wings or feathery projections. Every variety of plan or dodge or expedient has been adopted in turn to secure the self-same end; and, provided only it succeeds in securing it, any variety of them all is equally satisfactory. One might parallel it with the case of hatching birds' eggs. Most birds sit upon their eggs themselves, and supply the necessary warmth from their own bodies. But any alternative plan that attains the same end does just as well. The felonious cuckoo drops her foundlings unawares in another bird's nest; the ostrich trusts her unhatched offspring to the heat of the burning desert sand; and the Australian brush-turkeys, with vicarious maternal instinct, collect great mounds of decaying and fermenting leaves and rubbish, in which they deposit their eggs to be artificially incubated, as it were, by the slow heat generated in the process of putrefaction. Just in the same way, we shall see in the case of seeds that any method of dispersion will serve the plant's purpose equally well, provided only it succeeds in carrying a few of the young seedlings to a proper place in which they may start fair at last in the struggle for existence.

As in the case of the fertilization of flowers, so in that of the dispersal of seeds, there are two main ways in which the work is effected—by animals and by wind-power. I will not insult the intelligence of the reader at the present time of day by telling him that pollen is usually transferred from blossom to blossom in one or other of these two chief ways—it is carried on the heads or bodies of bees and other honey-seeking insects, or else it is wafted on the wings of the wind to the sensitive surface of a sister-flower. So, too, seeds are for the most part either dispersed by animals or blown about by the breezes of heaven to new situations. These are the two most obvious means of locomotion provided by Nature; and it is curious to see that they have both been utilized almost equally by plants, alike for their pollen and their seeds, just as they have been utilized by man for his own purposes on sea or land, in ship or windmill, or pack-horse, or carriage.

There are two ways in which animals may be employed to disperse seeds—voluntarily and involuntarily. They may be compelled to carry them against their wills; or they may be bribed and cajoled and flattered into doing the plant's work for it in return for some substantial advantage or benefit the plant confers upon them. The first plan is the one adopted by burrs and cleavers. These adhesive fruits are like the man who buttonholes you and won't be shaken off: they are provided with little curved hooks or bent and barbed hairs which catch upon the wool of sheep, the coat of cattle, or the nether integuments of wayfaring humanity, and can't be got rid of without some little difficulty. Most of them, you will find on examination, belong to confirmed hedgerow or woodside plants: they grow among bushes or low scrub, and thickets of gorse or bramble. Now, to such plants as these, it is obviously useful to have adhesive fruits or seeds: for, when sheep or other animals get them caught in their coats, they carry them away to other bushy spots, and there, to get rid of the annoyance caused by the foreign body, scratch them off at once against some holly-bush or blackthorn. You may often find seeds of this type sticking on thorns as the nucleus of a little matted mass of wool, so left by the sheep in the very spots best adapted for the free growth of their vigorous seedlings.

Even among plants which trust to the involuntary services of animals in dispersing their seeds, a great many varieties of detail may be observed on close inspection. For example, in hound's-tongue and goose-grass, two of the best-known instances among our common English weeds, each little nut is covered with many small hooks, which make it catch on firmly by several points of attachment to passing animals. These are the kinds we human beings of either sex oftenest find clinging to our skirts or trousers after a walk in a rabbit-warren. But in herb-bennet and avens each nut has a single long awn, crooked near the middle with a very peculiar S-shaped joint, which effectually catches on to the wool or hair, but drops at the elbow after a short period of withering. Sometimes, too, the whole fruit is provided with prehensile hooks, while sometimes it is rather the individual seeds themselves that are so accommodated. Oddest of all is the plan followed by the common burdock. Here, an involucre or common cup-shaped receptacle of hooked bracts surrounds an entire head of purple tubular flowers, and each of these flowers produces in time a distinct fruit; but the hooked involucre contains the whole compound mass, and, being pulled off bodily by a stray sheep or dog, effects the transference of the composite lot at once to some fitting place for their germination.

Those plants, on the other hand, which depend rather, like London hospitals, upon the voluntary system, produce that very familiar form of edible capsule which we commonly call in the restricted sense a fruit or berry. In such cases, the seed-vessel is usually swollen and pulpy; it is stored with sweet juices to attract the birds or other animal allies, and it is brightly colored so as to advertise to their eyes the presence of the alluring sugary food-stuff. These instances, however, are now so familiar to everybody that I won't dwell upon them at any length. Even the degenerate school-boy of the present day, much as he has declined from the high standard set forth by Macaulay, knows all about the way the actual seed itself is covered (as in the plum or the cherry) by a hard, stony coat which "resists the action of the gastric juice" (so physiologists put it, with their usual frankness), and thus passes undigested through the body of its swallower. All I will do here, therefore, is to note very briefly that some edible fruits, like the two just mentioned, as well as the apricot, the peach, the nectarine, and the mango, consist of a single seed with its outer covering; in others, as in the raspberry, the blackberry, the cloudberry, and the dewberry, many seeds are massed together, each with a separate edible pulp; in yet others, as in the gooseberry, the currant, the grape, and the whortleberry, several seeds are imbedded within the fruit in a common pulpy mass; and in others, again, as in the apple, pear, quince, and medlar, they are surrounded by a quantity of spongy edible flesh. Indeed, the variety that prevails among fruits in this respect almost defies classification: for sometimes, as in the mulberry, the separate little fruits of several distinct flowers grow together at last into a common berry; sometimes, as in the fig, the general flower-stalk of several tiny one-seeded blossoms forms the edible part: and sometimes, as in the strawberry, the true little nuts or fruits appear as mere specks or dots on the bloated surface of the swollen and overgrown stem, which forms the luscious morsel dear to the human palate.

Yet in every case it is interesting to observe that, while the seeds which depend for dispersion upon the breeze are easily detached from the parent plant and blown about by every wind of doctrine, the seeds or fruits which depend for their dispersion upon birds or animals always, on the contrary, hang on to their native boughs to the very last, till some unconscious friend pecks them off and devours them. Haws, rose-hips, and holly-berries will wither and wilt on the tree in mild winters, because they can't drop off of themselves without the aid of birds, while the birds are too well supplied with other food to care for them. One of the strangest cases of all, however, is that of the mistletoe, which, living parasitically upon forest-boughs and apple trees, would, of course, be utterly lost if its berries dropped their seeds on to the ground beneath it. To avoid such a misfortune, the mistletoe-berries are filled with an exceedingly viscid and sticky pulp, surrounding the hard little nut-like seeds; and this pulp makes the seeds cling to the bills and feet of various birds which feed upon the fruit, but most particularly of the missel-thrush, who derives his common English name from his devotion to the mistletoe. The birds then carry them away unwittingly to some neighboring tree, and rub them off, when they get uncomfortable, against a forked branch—the exact spot that best suits the young mistletoe for sprouting in. Man, in turn, makes use of the sticky pulp for the manufacture of bird-lime, and so employs against the birds the very qualities which the plant intended as a bribe for their kindly services.

Among seeds that trust for their dispersal to the wind, the commonest, simplest, and least evolved type is that of the ordinary capsule, as in the poppies and campions. At first sight, to be sure, a casual observer might suppose there existed in these cases no recognizable device at all for the dissemination of the seedlings. But you and I, most excellent and discreet reader, are emphatically *not*, of course, mere casual observers. *We* look close, and go to the very root of things. And when we do so, we see for ourselves at once that almost all capsules open—where? why, at the top, so that the seeds can only be shaken out when there is a high enough wind blowing to sway the stems to and fro with some violence, and scatter the small, black grains inside to a considerable distance. Furthermore, in many instances, of which the common poppy-head is an excellent example, the capsule opens by lateral pores at the top of a flat head—a further precaution which allows the seeds to get out only by a few at a time, after a distinct jerk, and so scatters them pretty evenly, with different winds, over a wide circular space around the mother-plant. Experiment will show how this simple dodge works. Try to shake out the poppy-seed from a ripe poppy-head on the plant as it grows, without breaking the stem or bending it unnaturally, and you will easily see how much force of wind is required in order to put this unobtrusive but very effective mechanism into working order.

The devices of this character employed by various plants for the dispersal of seeds even in ordinary dry capsules are far too numerous for me to describe in full detail, though they form a delightful subject for individual study in any small suburban garden. I will only give one more illustrative case, just to show the sort of point an amateur should always be on the lookout for. There is an extremely common, though inconspicuous, English weed, the mouse-ear chickweed, found everywhere in flower-beds or grass-plots, however small, and noticeable for its quaint little horn-shaped capsules. These have a very odd sort of twist or cock-up in the middle, just above the part where the seeds lie; and they open at the top by ten small teeth, pointed obliquely outward, for no apparent reason. Yet every point has a meaning of its own for all that. The plant is one that lies rather close upon the ground; and the effect of this twist in the capsule is that the seeds, which are relatively heavy, and well stored with nutriment, can never get out at all, unless a very strong wind is blowing, which sweeps over the herbage in long, quick waves, and carries everything it shakes out for great distances before it. So much design have even the smallest weeds put into the mechanism for the dispersion of their precious seeds, the hope of their race and the earnest of their future!

Artillery marks a higher stage than the sling and the stone. Just so, in many plants, a step higher in the evolutionary scale as regards the method of dispersion, the capsule itself bursts open explosively, and scatters its contents to the four winds of heaven. Such plants may be said to discharge their grains on the principle of the bow and arrow. The balsam is a familiar example of this startling mode of moving to fresh fields and pastures new: its capsule consists of five long, straight valves, which break asunder elastically the moment they are touched, when fully ripe, and shed their seeds on all sides, like so many small bombshells. Our friend the squirting cucumber, which served as the prime text for this present discourse, falls into somewhat the same category, though in other ways it rather resembles the true succulent fruits, and belongs, indeed, to the same family as the melon, the gourd, the pumpkin, and the vegetable-marrow, almost all of which are edible and in every way fruit-like. Among English weeds, the little bittercress that grows on dry walls and hedge-banks forms an excellent example of the same device. Village children love to touch the long, ripe, brown capsules on the top with one timid finger, and then jump away, half laughing, half terrified, when the mild-looking little plant goes off suddenly with a small bang and shoots its grains like a catapult point-blank in their faces.

It is in the tropics, however, that these elastic fruits reach their highest development. There they have to fight, not merely against such small fry as robins, squirrels, and harvest-mice, but against the aggressive parrot, the hard-billed toucan, the persistent lemur, and the inquisitive monkey. Moreover, the elastic fruits of the tropics grow often on spreading forest trees, and must therefore shed their seeds to immense distances if they are to reach comparatively virgin soil, unexhausted by the deep-set roots of the mother-trunk. Under such exceptional circumstances, the tropical examples of these elastic capsules are by no means mere toys to be lightly played with by babes and sucklings. The sand-box tree of the West Indies has large round fruits, containing seeds about as big as an English horsebean; and the capsule explodes, when ripe, with a detonation like a pistol, scattering its contents with as much violence as a shot from an air-gun. It is dangerous to go too near these natural batteries during the shooting season. A blow in the eye from one would blind a man instantly. I well remember the very first night I spent in my own house in Jamaica, where I went to live shortly after the repression of "Governor Eyre's rebellion," as everybody calls it locally. All night long I heard somebody, as I thought, practicing with a revolver in my own back garden; a sound which somewhat alarmed me under those very unstable social conditions. An earthquake about midnight, it is true, diverted my attention temporarily from the recurring shots, but didn't produce the slightest effect upon the supposed rebel's devotion to the improvement of his marksmanship. When morning dawned, however, I found it was only a sand-box tree, and that the shots were nothing more than the explosions of the capsules. As to the wonderful tales told about the Brazilian cannon-ball tree, I can not personally indorse them from original observation, and will not stain this veracious page with any second-hand quotations from the strange stories of modern scientific Munchausens.

Still higher in the evolutionary scale than the elastic fruits are those airy species which have taken to themselves wings like the eagle, and soar forth upon the free breeze in search of what the Americans describe as "fresh locations." Of this class, the simplest type may be seen in those forest trees, like the maple and the sycamore, whose fruits are flattened out into long expansions or parachutes, technically known as "keys," by whose aid they flutter down obliquely to the ground at a considerable distance. The keys of the sycamore, to take a single instance, when detached from the tree in autumn, fall spirally through the air, owing to the twist of the winged arm, and are carried so far that, as every gardener knows, young sycamore trees rank among the commonest weeds among our plots and flower-beds. A curious variant upon this type is presented by the lime, or linden, whose fruits are in themselves small, wingless nuts; but they are borne in clusters upon a common stalk, which is winged on either side by a large membranous bract. When the nuts are ripe, the whole cluster detaches itself in a body from the branch, and flutters away before the breeze by means of the common parachute, to some spot a hundred yards off or more, where the wind chances to land it.

The topmost place of all in the hierarchy of seed life, it seems to me, is taken by the feathery fruits and seeds which float freely hither and thither wherever the wind may bear them. An immense number of the very highest plants—the aristocrats of the vegetable kingdom, such as the lordly composites, those ultimate products of plant evolution—possess such floating feathery seeds; though here, again, the varieties of detail are too infinite for rapid or popular classification. Indeed, among the composites alone—the thistle and dandelion tribe with downy fruits—I can reckon up more than a hundred and fifty distinct variations of plan among the winged seeds known to me in various parts of Europe. But if I am strong, I am merciful: I will let the public off a hundred and forty-eight of them. My two exceptions shall be John-go-to-bed-at-noon and the hairy hawkweed, both of them common English meadow-plants. The first, and more quaintly named, of the two has little ribbed fruits that end in a long and narrow beak, supporting a radial rib-work of spokes like the frame of an umbrella; and from rib to rib of this framework stretch feathery cross-pieces, continuous all round, so as to make of the whole mechanism a perfect circular parachute, resembling somewhat the web of a geometrical spider. But the hairy hawkweed is still more cunning in its generation; for that clever and cautious weed produces its seeds or fruits in clustered heads, of which the central ones are winged, while the outer are heavy, squat, and wingless. Thus does the plant make the best of all chances that may happen to open before it; if one lot goes far and fares but ill, the other is pretty sure to score a bull's-eye.

These are only a few selected examples of the infinite dodges employed by enlightened herbs and shrubs to propagate their scions in foreign parts. Many more, equally interesting, must be left undescribed. Only for a single case more can I still find room—that of the subterranean clover, which has been driven by its numerous enemies to take refuge at last in a very remarkable and almost unique mode of protecting its offspring. This particular kind of clover affects smooth and close-cropped hillsides, where the sheep nibble down the grass and other herbage almost as fast as it springs up again. Now, clover seeds resemble their allies of the pea and bean tribe in being exceedingly rich in starch and other valuable foodstuffs. Hence, they are much sought after by the inquiring sheep, which eat them off wherever found, as exceptionally nutritious and dainty morsels. Under these circumstances, the subterranean clover has learned to produce small heads of bloom, pressed close to the ground, in which only the outer flowers are perfect and fertile, while the inner ones are transformed into tiny, wriggling corkscrews. As soon as the fertile flowers have begun to set their seed, by the kind aid of the bees, the whole stem bends downward, automatically, of its own accord; the little corkscrews then worm their way into the turf beneath; and the pods ripen and mature in the actual soil itself, where no prying ewe can poke an inquisitive nose to grub them up and devour them. Cases like this point in certain ways to the absolute high-water-mark of vegetable ingenuity: they go nearest of all in the plant-world to the similitude of conscious animal intelligence.—*Cornhill Magazine.*

SKETCH OF GEORGE CATLIN.

GEORGE CATLIN'S work was not directly scientific, but rather artistic. It was inspired, nevertheless, by a scientific motive; and it has resulted in leaving to the world the fullest and most various records that it has, in picture and written description, of the aboriginal tribes of both Americas, as they were before their customs and ideas were modified by civilization, or they were contaminated by white influences—a most precious collection of original material for future anthropologists to study.

George Catlin was born in Wilkesbarre, Pa., July 26, 1796, and died in Jersey City, N. J., December 23, 1872. He was descended from a family who "came over with the Conqueror," his ancestor of that period having been recorded in Domesday Book as possessing in 1087 two knights' fees of land in Kent. The Catlins have been seated ever since at Newington, Kent; and various members of the family have been honorably employed in the service of the kings of England and other powers. Thomas Catlin, the first ancestor in the United States, with two brothers, came from England or Wales some time before 1643, when he is mentioned as having been settled in Hartford, Conn. Putnam Catlin, the artist's father, served in the colonial forces for six years during the Revolutionary War. His mother, Polly Sutton, was the daughter of an early settler of Wyoming Valley, who was engaged in the battles with the Indians at the time of the massacres; and she was herself captured by the Indians at the surrender of Forty Fort.

Mrs. Catlin was a Methodist and a devout Christian; while the father, a practicing lawyer, was "a philosopher, professing no particular creed, but keeping and teaching the commandments." In 1797 the family removed to Ona-qua-qua Valley, Broome County, N. Y., traveling on horseback over an Indian trail, the baby George being carried in his mother's arms. They afterward removed, at different times, to Hop Bottom, Montrose, and Great Bend, Pa.

Until he was about fifteen years old the boy lived much with Nature, and became an accomplished hunter and fisherman—occupations for which he had an inveterate propensity, and from which his father and mother had great difficulty in turning his attention to books. By virtue of his associations his mind and imagination were filled with stories of Indians and Indian life. His parents had vivid recollections of the terrible adventures in which they had participated; his father's generous hospitality caused the place to be frequented by Revolutionary soldiers, Indian fighters, hunters, trappers, and explorers, for whose stories he had an always ready ear; even the noonday rests in the farm-fields were enlivened by the relation of incidents of the early settlement; and the very valley where he lived had been the rendezvous of Brant and his army during the frontier war.

His early training, which was that usual for the sons of persons of means in the colonies, was carefully attended to by his father and his mother. In 1817 and 1818 he attended the law school of Reeves & Gould, at Litchfield, Conn. He continued his law studies in Pennsylvania, and entered upon the practice of the profession in the courts of Luzerne and the adjoining counties. But during the time of his practice, from 1820 to 1823, the passion for painting, in which he had already in Connecticut become noted as an amateur, was getting the advantage of him, and soon all his love of pleading gave way to it; and, he says, "After having covered nearly every inch of the lawyer's table (and even encroached upon the judge's bench) with penknife, pen and ink, and pencil sketches of judges, juries, and culprits, I very deliberately resolved to convert my law library into paint pots and brushes, and to pursue painting as my future and apparently more agreeable profession." He settled in Philadelphia in 1823, and was at once admitted to the fraternity of artists there, which included Thomas Sully, John Nagle, Charles Wilson, and Rembrandt Peale. In the next year he was admitted as an academician of the Pennsylvania Academy of Fine Arts. He was most successful as a miniature painter in water-colors on ivory. Among his more famous paintings were one of Mrs. Madison in a turban; the Virginia Constitutional Convention of 1839; the portrait of De Witt Clinton, which hangs in the Governor's Room of the New York City Hall, and of which the Franklin Institute, of Rochester, has a copy from his hand; and portraits of members of the Legislature and other prominent men of New York. He visited New York, Buffalo, Norfolk, and other cities in the exercise of his art; and often saw the delegations of Indians that were in the habit of visiting Washington at that period of our history. While in Philadelphia, he writes, his mind was continually reaching for some branch or enterprise of the art "on which to devote a whole lifetime of enthusiasm, . . . a delegation of some ten or fifteen noble and dignified looking Indians from the wilds of the far West suddenly arrived in the city, arrayed and equipped in all of their classic beauty, with shield and helmet, with tunic and manteau, tinted and tasseled off exactly for the painter's palette." Having an eye for nature rather than for the conventionalities of civilization, he had long been of the opinion that the wilderness of our country afforded models equal to those from which the Grecian sculptors transferred inimitable grace and beauty to marble; and a short experience in the woods among Indians confirmed him in this view. In the midst of his success as a painter, he wrote in 1861, "I again resolved to use my art, and so much of the labors of my future life as might be required, in rescuing from oblivion the looks and customs of the vanishing races of native man in America, to which I plainly saw they were hastening before the approach and certain progress of civilization." If he should live to accomplish his design, he thought, "the result of my labors will doubtless be interesting to future eyes, who will have little else left from which to judge of the original inhabitants of this simple race of beings." So he set out alone, unaided, and unadvised, to collect his portraits and illustrations of primitive looks and customs, to set them up "in a gallery, unique and imperishable, for the use and benefit of future ages." He was never even comfortably off in money matters, says his biographer, Mrs. Clara Catlin Clarke, "relying for his livelihood upon his brush or his pen. He lived poor and died the same. He received no pecuniary aid, governmental or individual, in the prosecution of his work." He accomplished it with remarkable thoroughness.

He followed this work for forty-two years, from 1829 to 1871, and during that time traveled through the wildernesses of North and South America, and visited Europe, making his name known everywhere. During eight years, from 1829 till 1838, he lived among the Indians, traders, trappers, and hunters of the West.

In 1830 and 1831 he accompanied Governor Clark, Superintendent of Indian Affairs, to treaties held with the Winnebagoes and Menomonees, the Shawnees and Sacs and Foxes, and in these interviews began the series of his Indian paintings. In 1831 he visited, with Governor Clark, the Kansas, and returned to St. Louis. In 1832 he painted the portraits of Black Hawk and his warriors, prisoners of war. In the same year, on his second journey, he ascended the Missouri, by steamer, to Fort Union, mouth of the Yellowstone, and descended the Missouri to St. Louis in a canoe with two men, steering it the whole distance of two thousand miles with his own paddle, visiting and painting ten tribes. Of these tribes the most important were the Mandans, to whom he devoted more time and labor than any other in North America. In 1833 he ascended the Platte to Fort Laramie, visiting villages of the Pawnees, Omahas, and Otoes, and seeing many Arapahoes and Cheyennes, and rode to the shores of the Great Salt Lake, while the Mormons were yet building their temple at Nauvoo. In 1834 he accompanied a regiment of mounted dragoons to the Comanches and other Southwestern tribes, making an extensive journey and seeing many Indians of various tribes; then from Fort Gibson, Ark., on his horse "Charley," without a road or a track, rode to St. Louis, a distance of five hundred and fifty miles, guided by his pocket compass, and swimming the rivers as he met them. In 1835 he ascended the Mississippi to the Falls of St. Anthony, saw the Mississippi Sioux, the Ojibways and Saukees or Sacs, and descended the Mississippi to St. Louis in a bark canoe with one man, steering with his own paddle. In 1836 he made a second visit to the Falls of St. Anthony, steaming from Buffalo to Green Bay, ascending the Fox and descending the Wisconsin Rivers, six hundred miles in a bark canoe to Prairie du Chien, and thence by canoe four hundred and fifty miles to the Falls of St. Anthony. Thence he ascended the St. Peter's to the "Pipestone Quarry" on the Côteau des Prairies, and descended the St. Peter's in a canoe, with a companion, to the Falls of St. Anthony, and from them a second time to St. Louis in a bark canoe, nine hundred miles, steering with his own paddle. In 1837 he went to the coast of Florida to see the Seminoles and Euchees, and in the same years made a voyage from New York to Charleston to paint

Osceola and the other Seminole chiefs, then prisoners of war. The letters embodying the observations made during these journeys—in which thirty-eight tribes sat to him for their portraits—on the tribes and country furnished the illustrations and text for the book, Illustrations of the Manners, Customs, and Condition of the North American Indians, which passed in England through more than twenty-five editions, and of which more than sixty thousand copies were sold.

Mr. Catlin's chief object on these journeys was to observe the Indian as a man, and to perpetuate the representation of the kind of a man he was. He watched him in every aspect, caught him in every mood, studied him in every relation, and put him down, on canvas or in his notes, as he found him. He enjoyed and improved, to the full extent of his power, opportunities which have occurred to few so ready to make a record of them, and will never occur again to any one, of becoming familiar with the red man in his natural, unsophisticated state, with the intention of making mankind, as far as possible, a sharer in his privileges.

Most of the places he visited, the names of many of which have become familiar to us, and which now seem commonplace, were then away out beyond the bounds of civilization, and visited by the ordinary tourist, if visited by him at all, with an apprehension not unlike that with which he would now start out for Central Africa. The Indians knew little of the white man, and his inventions were strange and mysterious to them. Thus, the people on the Yellowstone had never seen or heard of a steamboat, and at some places were at a loss what to do or how to act at the sight of one.

The art of portrait-painting was new to the savages, and the strange, whimsical, and superstitious notions which they conceived of Mr. Catlin's operations were the source of many curious incidents. The portraits produced great excitement in the villages, with intense interest in the personality of the artist. The people pronounced him the greatest medicine-man in the world, for he made living beings; they said "they could see their chiefs alive in two places; those that he had made were a little alive: they could see their eyes move, could see them smile and laugh, and if they could laugh they could certainly speak, if they should try, and they must therefore have some life in them." The squaws generally agreed that "they had discovered life enough in them to render my medicine too great for the Mandans; saying that such an operation could not be performed without taking from the original something which I put in the picture, and they could see it move, could see it stir." Then the cry went around that the artist was a dangerous man; "one who could make living persons by looking at them, and at the same time could, as a matter of course, destroy life in the same way, if I chose." When a movement was made to expel him from a village, and a council was held about the matter, which sat for several days, he got admittance to their council, and assured them, he says, "that I was but a man like themselves; that my art had no medicine or mystery about it, but could be learned by any of them if they would practice it as long as I had; and that in the country where I lived brave men never allowed their squaws to frighten them with foolish whims and stories. They all immediately arose, shook me by the hand, and dressed themselves for their pictures. After this there was no further difficulty about sitting—all were ready to be painted; the squaws were silent, and my painting-room a continual resort for the chiefs and medicine-men." But Mr. Catlin always noticed that, when a picture was going on, the braves who were assisting kept passing the pipe around, smoking for the success of the picture and the preservation of the sitter. Then he was feasted, a doctor's rattle was presented to him, and a magical wand, or doctor's staff, "strung with claws of the grizzly bear, with hoofs of the antelope, with ermine, with wild sage and bats' wings—and perfumed with the choice and savory odor of the polecat; a dog was sacrificed and hung by the legs over my wigwam, and I was therefore and thereby initiated into the arcana of medicine or mystery."

Mr. Catlin was called by the Iowa Indians *Chip-pe-ho-la;* by the Mandans, *Te-ho-pe-nee Wash-ee*, or Great Medicine White Man; and by the Sioux at Fort Pierre, *Ee-cha-zoo-kah-ga-wa-kou*, the Medicine Painter, and also *We-chash-a-wa-kou*, the Painter. Associating with the Indians almost constantly, and seeing their best side, Mr. Catlin's sympathies were wholly enlisted for them; and we find much in his observations appreciative of their character and revealing an anxious interest in their future. He often speaks as one who felt that a doom of extermination which they did not deserve had been pronounced against them. He wrote an "Indian creed" in 1868, pertinently to his being called "the Indian-loving Catlin," in which he described those people as having always loved him and made him welcome to the best they had; as being honest without laws, having no jails or poorhouses, keeping the commandments without ever having read them or heard them preached from the pulpit, having never taken the name of God in vain, loving their neighbors as themselves, worshiping God without a Bible and believing that God loved them also, and—"I love all people who do the best they can, and oh, how I love a people who don't live for the love of money!" He asserted, in his North American Indians, that the Indian "is everywhere, in his native state, a highly moral and religious being, endowed by his Maker with an intuitive knowledge of some great author of his being and the universe; in dread of whose displeasure he constantly lives, with the apprehension before him of a future state, where he expects to be rewarded or punished, according to the merits he has gained or forfeited in this world." He found him the worshiper of a spiritual God, with no idolatry. He discerned the evil of allowing traders to go among the Indians to corrupt them, and thought that, if they were obliged to come to the settlements to do their trading, they would enjoy the advantages of competition, and see the better features of our civilization. His theories respecting the origin of the Indians do not seem to have taken settled shape. He believed that the primary race did not come here from abroad, but originated here on the soil independently of other races; although wanderers from other lands may have mingled with it. He found reasons for supposing that there may have been a Jewish element in the race, but not that the race was derived from the Jews; and he speculated upon the possible derivation of the Mandans from a Welsh colony under Prince Madoc in the early part of the fourteenth century. There are not many scientific observations in his itineraries. His journal at Fort Gibson, in 1834, contains a notice of the death of Mr. Beyrich, a Prussian botanist, who had made an immense collection of plants, and died at Fort Gibson while engaged in changing and drying them.

Mr. Catlin supported himself in his journeys by painting portraits and by the sale of his books. It was his custom to leave the Indian country in the fall and go in his canoe down to St. Louis or New Orleans. There he would select some place promising good custom and settle himself as a portrait-painter for the winter. His collections having become large enough to form a museum and gallery, he took them to Europe and exhibited them at the principal capitals. His first adventure of this kind was fairly successful, and he returned home with a competence. His visit to France, from 1845 to 1848, led to pecuniary disaster, and was saddened by the loss of his wife and son; and in 1852 he suffered a financial wreck in London, from which he never recovered.

Between 1852 and 1857 Mr. Catlin made three voyages from Paris to South and Central America. He found great difficulty in getting the Indians of the Amazon to sit for their pictures, but by catching them unawares and sketching from his boat while they were detained on the shore by some pretext of entertainment, he was able to make sketches among thirty different tribes, on the Amazon, the Uruguay, the Yucayali, and in the open air of the pampas and llanos, containing many thousand people, in their canoes, at their fishing occupations, and in groups on the river's shore.

After he returned from his South American campaigns, Mr. Catlin lived in Brussels, upon the proceeds of his brush, and there began the preparation of his cartoon collection.

Mr. Catlin died of an illness contracted from an exposure which he suffered in Washington, in October, 1872. He was removed thence to Jersey City, where his daughters and his brother-in-law, the Hon. Dudley S. Gregory, were living. His collection of pictures now belongs to the Smithsonian Institution, and constitutes the George Catlin Indian Gallery of the United States National Museum. In his paintings he sought to represent the truth, and invented nothing. He regarded the domestic and every-day customs, habits, and manners of the Indians as the essentials to the proper study of their origin and descent, and aimed to reproduce them thoroughly. His principal books were Letters and Notes on the Manners, Customs, and Condition of the North American Indians; written during eight years of travel among the wildest tribes of Indians in North America, first published in 1841, and reproduced in several editions, in English and German, with divers variations of title; and Life amongst the Indians, a book for youth, 1867; also published in French. The list also includes works on the O-kee-pa, a religious ceremony of the Mandans; catalogues of his gallery; a pamphlet on breathing with the mouth shut, giving the results of experiences and observations acquired during his life among the Indians, 1865; a pamphlet concerning a Steam Raft suggested as a Means of Security to Human Life on the Ocean, 1850; Last Rambles amongst the Indians of the Rocky Mountains and the Andes, 1868; The Lifted and Subsided Rocks of America, with their Influence on the Oceanic, Atmospheric, and Land Currents, and the Distribution of Races, 1870; a Letter to William Blackman, concerning his life among the aboriginal races of America; and newspaper, review, and magazine notes and articles.

He put forward in 1832 a suggestion for forming a large reservation of public lands to be a nation's park, containing man and beast in all the wildness and freshness of their natural beauty, saying that he would want no better monument than the reputation of having been the founder of such an institution. In 1845 he published a plan for disengaging and floating quarter-decks on steamers and other vessels for the purpose of saving human lives at sea, and proceeded to take out a patent for it, but found afterward that he had been anticipated. In 1842 he was invited to lecture at the Royal Institution in London, and took advantage of the occasion to introduce a subject on which he had long meditated—that of forming a museum of mankind, to contain and perpetuate the looks and manners and history of all the declining and vanishing races of mankind.

EDITOR'S TABLE.

THE NEW JESUITISM AND SOCIAL REFORM.

THE General of the Salvation Army has, without intending it, rendered a very considerable service to society by provoking just the kind of discussion that was most wanted at the present time in regard to the best means of combating the poverty which seems ever to dog the steps of civilization. The "General" was perfectly confident that, if the public would only supply him with sufficient money, he could grapple with the problem as far as the city of London was concerned. His confidence in himself begot confidence in him on the part of others, and sufficient money has been placed in his hands to enable him to set about working out his experiment. But, while a portion of the public has thus proved responsive, another portion has sought to know something more about the "General's" schemes and methods before deciding on giving him support. Every one is probably aware of the position taken up by Prof. Huxley in reference to this matter. Having been consulted by a friend as to whether he would advise the giving of a large sum of money to the "General's" fund, he frankly stated, in a letter to the London Times, that the methods of the Salvation Army did not inspire him with confidence. What he saw was a vast organization centering round Mr. Booth, and obeying his commands with a submission almost as absolute as that rendered by a monk to the head of his order. In Prof. Huxley's opinion the world has seen enough of this kind of thing, and has had sufficient experience of the corruption that such personally-governed corporations naturally undergo. His conclusion, therefore, is that it would not be wise on the part of any one who does not fully believe in Mr. Booth as a spiritual leader and teacher to devote money to a scheme the main result of which would certainly be to increase that individual's personal influence. The objections thus taken on general grounds were found to be fully justified by the special facts which further inquiry revealed. The methods of the "army" were found to be such as an absolute autocracy might be expected to develop. Under such a system policy becomes paramount, and moral principles, if they conflict with policy, must fare as best they may. As Prof. Huxley's letters to the Times have lately been republished in this country, we should recommend those who are interested in the question as to the expediency of trusting to Mr. Booth's army to undertake social work, and of furnishing it with funds for the purpose, to study that question for themselves in the light of the facts which Prof. Huxley brings forward.

Meantime, we protest on broad scientific grounds against the idea of intrusting social work to any organization the methods and principles of which are not open to the fullest criticism, or to one the operations of which are under the absolute control of a single will. Mr. Booth professes that his main object is to save souls. The saving of souls is, in his opinion, bound up with the adoption of a certain theological creed. He really aims, while satisfying material wants, at extending the sway of his own ideas and beliefs. He wants to transform society into a salvation army, and he asks for money to enable him to carry on the work directly and indirectly. Let those assist who believe that it is well for the world that Mr. Booth's ideas should be more widely spread among mankind; but we do not see with what consistency men who hold that what society lacks is the bread of knowledge and the discipline of firm governmental administration can lend their aid to a scheme which totally subordinates knowledge to dogma, and seeks to solve social difficulties by a kind of *deus ex machina* intervention of a somewhat fanatical and not overscrupulous individual. We do not grudge Mr. Booth the utmost support he can get from persons on the same plane of thought as himself, and who believe that it is a good thing that he should wield an autocratic power over so many thousands of his fellow-men; but we can not believe that those who regard his way of thinking as narrow and unintelligent, and who disapprove of the concentration of unlimited power, however acquired, in the hands of one man, are justified in directly helping to strengthen his organization. It is right, however, that those who fight under the banner of science should note what is going on and be admonished thereby. If the forces of reaction are in motion, the forces of progress should not be inactive. It is time that the whole problem of social reform should be considered in the light of the best knowledge now obtainable. Medical and sanitary science have much to say to it, and so has political economy. History, psychology, and ethics should all be able to throw light upon it, and anthropology might render more or less assistance. One unfortunate result of the undue specialization of scientific study now prevalent is that scientific men are, or feel themselves to be, cut off to a great extent from large questions of every-day life; but here certainly is one of pressing importance which should not be left to ignoramuses and fanatics to solve in their own crude way. We do not hesitate to say that the scientific men of this generation will gravely fail in their duty if they do not collectively strive to bring the improved knowledge of the time to bear on social problems. If we can not be helped to discern all we ought to do, it would be something if we could be led to see what we ought *not* to do. The prominence which a man like "General" Booth is able to achieve is largely due to the abstention from social concerns of men who ought to be able to take a wider and more sober view of the situation than he. There are social problems to be dealt with in this country just as there are in England, though they may not have reached so acute a stage; and we trust it may not be left to the Salvation Army to take up on this side of the Atlantic work which might so much better be coped with by scientifically directed effort.

CHARITY AS A FETICH.

A FETICH is commonly understood to be some inanimate object ignorantly and blindly worshiped as possessing supernatural powers. In the March number of the Westminster Review Mrs. Emily Glade Ellis discusses The Fetich of Charity. The expression is happily chosen. It is hardly too much to say that, with the Christian world in general, charity is little better than a fetich. It is blindly believed in as something that must do good, that must bless both the giver and the receiver. True, this fetich, like other fetiches, often does not do the things that are expected of it, but, on the contrary, seems to take a spiteful pleasure in doing the opposite of what was expected; still, the faith of its worshipers is not shaken. The African savage will sometimes treat his uncomplying fetich to a sound drubbing; but the Christian savage (shall we say?) has a casuistry at his command that enables him at all times to make apologies both for his fetich and for himself. How richly the fetich deserves to be drubbed, or rather, to use a more rational phrase, how strong the case is for discarding it as a fetich, any one may learn from a perusal of Mrs. Ellis's article. Her arraignment of the fetich falls under five heads: "(1) It invites and creates gross errors of administration. (2) It shifts the duties of the whole community on to the shoulders of a generous minority. (3) It demoralizes those who give. (4) It demoralizes those who receive. (5) It intensifies the very evils it was designed to cure." The facts adduced in support of this indictment are very striking, and, we do not hesitate to say, conclusive. We are glad to notice that this article only purports to be a first installment of a longer discussion. No subject could be more timely, and we trust that the writer and those who with her appreciate the full evil wrought by a misguided sentimentality will persevere in their efforts to enlighten the public, with a view to the overthrow of methods that are so obviously hurtful, and the substitution therefor of a rational dependence on law in the widest sense.

LITERARY NOTICES.

The American Race: A Linguistic Classification and Ethnographic Description of the Native Tribes of North and South America. By Daniel G. Brinton. New York: N. D. C. Hodges. Pp. 392. Price, $2.

This is the first attempt—Dr. Latham's previous work of nearly forty years having been only partly in that direction—known to the author, at a systematic classification of the whole American race on the basis of language. While the value of physical data, culture, and traditional history is not depreciated, they are in this work constantly made subordinate to relationship as indicated by grammar and lexicography. Dr. Brinton is not alone in recognizing this fact, for the linguistic classification is also employed as the predominant criterion by the Bureau of Ethnology of the United States and the similar departments in the Governments of Canada and Mexico. The grammatical structure of the language is recognized as superior to the lexical elements in deciding on relationship; and this, too, is in agreement with the general opinion of the best scholars. Especial attention is paid to those parts of the continent whose ethnography remains obscure. The various theories of the origin of American man are reviewed. As to the time of his appearance here, the author agrees with most contemporary anthropologists that it was during the Glacial epoch. Too much importance should not be attached to the indications of an extremely early origin afforded by certain finds of human relics on the Pacific slope—for allowance has to be made for the disturbances to which the soil has been subjected in those regions. The hypothesis of an elevation of the bed of the North Atlantic above water during the Glacial period is accepted to account for the access of man to this continent. The physical traits of the American man of to-day are supposed to have been developed since his arrival, and while he was in his first American home, which is supposed, on the evidence of the superior adaptability of even the tropical Indian to a temperate climate, to have been east of the Rocky Mountains and between the receding wall of the continental ice-sheet and the Gulf of Mexico. The physical characteristics of the Indians North and South are found to be subject to considerable variations, but, "on the whole, the race is singularly uniform in its physical traits, and individuals taken from any part of the continent could easily be mistaken for inhabitants of numerous other parts. This uniformity finds one of its explanations in the geographical features of the continent, which are such as to favor migrations in longitude, and thus prevent the diversity which especial conditions of latitude tend to produce." Beyond all other criteria of a race must rank its mental endowments. Judged by accomplished results, rather than supposed endowments, "the American race certainly stands higher than the Australian, the Polynesian, or the African, but does not equal the Asian. No hard-and-fast line of difference in degrees of culture can be drawn between the tribes; and, when closely analyzed, the difference between the highest and the average culture of the race is much less than has usually been taught." America everywhere at the time of discovery is found to have been in the polished stone age. The religious sentiment was awake in all the tribes of the continent, and even the lowest tribes had myths and propitiatory rites; and there is a singular similarity in these myths. The psychic identity of the Americans is well illustrated in their languages, which are strikingly alike in their logical substructure. The precise number of linguistic stocks in use in America at the discovery has not been made out. The Bureau of Ethnology has defined fifty-nine north of Mexico, forty of which were confined to the narrow strip between the Rocky Mountains and the Pacific. The stocks, including the South American, are divided by Dr. Brinton into five groups —the North Atlantic, the North Pacific, the Central, the South Pacific, and the South Atlantic; and each stock is considered separately.

Woman's Work in America. Edited by Annie Nathan Meyer. New York: Henry Holt & Co. Pp. 457. Price, $1.50.

This voluminous record deals with a subject which within the past generation has risen to great interest and importance to both sexes. The volume comprises an editor's preface, an introduction of two pages by Julia Ward Howe, and seventeen chapters, by as many writers (all women), three of them being on the education of women in different sections of the country, while the others deal with different fields of activity into which women have made their way, generally against obstacles. Of the latter fourteen chapters, seven treat of special divisions of woman's work in philanthropy, and the subjects of the other seven are woman in literature, in journalism, in medicine, in the ministry, in law, in the state, and in industry. The editor explains, in answer to the question, which has been asked her, why she has no chapter on woman in marriage, that the book is restricted to fields "in which women, if entrance were not absolutely denied them, were at least not welcomed nor valued." The editor had a perfect right to limit the book as she saw fit, but thus limited it does not fulfill the promise of its title. An exact title would be, The Extension of Woman's Work in America; the present one is a weapon for those who charge inexactness as a characteristic fault of women. The occupations that are omitted, including the one above mentioned, domestic service, teaching, and dressmaking represent the greater part of the work that women do, and others are such as the sex has won some of its proudest laurels in, namely, the fine arts and the stage. Although this record seems to have been limited by a purpose of celebrating triumphs over public opinion, it contains much information, and recounts many noble works. The profession in which woman has won the highest success in spite of the most determined opposition, and hence has the greatest victory to celebrate, is that of medicine. The chapter on this subject is by Mary Putnam Jacobi, M. D. It traces the history of the movement with considerable detail, giving many names and dates, but without permitting the statistical to overshadow the literary features of the essay. The most important division of the volume is the group of occupations included under the general head Woman in Industry. The essay with this title is by Alice H. Rhine; it describes the transfer of spinning, weaving, and knitting from the home to the factory, the change in the labor of seamstresses which the sewing machine introduced, the establishment of exchanges for goods made by women, the participation of women in trades-unions, various State investigations of the work of women, and some of the legislation based on the information thus gathered. It also gives an account of the rise of woman's education in industrial art, the establishment of various organizations to furnish working-women with comfortable living, to protect them from being cheated out of their wages or savings, and to teach them various gainful occupations, and closes with glowing praise of the Knights of Labor and the principles of socialism. Little or nothing is said about saleswomen, or women as stenographers, typewriters, telegraphers, cashiers, book-keepers, Government clerks, canvassers, and teachers of cookery. Miss Rhine calls the sewing-machine a curse, "like all other labor-saving machines"—a delusion which is mostly confined to the uneducated. One quality for which this essay deserves praise is its freedom from useless words. The paper on Woman in Literature, by Helen G. Cone, records much of glorious achievement. It is rather apologetic, assigning lack of advantages and opportunities as the reason why still more women have not succeeded in this field. This plea gives scant credit for genius to the women who have done well. Many of the essays overrun into the fields that belong to others; most of them contain irrelevant matter or are overdressed with rhetoric and poetical quotations; nursing as a means of support is mixed up with the charitable care of the sick; and there is other evidence of defective arrangement and editing. Taking it altogether, however, the book has a great deal to tell to any one who is interested in "the woman question," and this consists in not only the facts which the writers have set forth, but largely, also, in what the character of the volume unconsciously reveals of woman's intellectual peculiarities, her mode of action in various circumstances, her attitude toward certain questions of the day, etc.

Physical Religion. By F. Max Müller. London and New York: Longmans, Green & Co. Pp. 410.

This volume contains the author's second course of Gifford Lectures, which were delivered before the University of Glasgow in 1890. The first course was chiefly of an introductory character. In it the questions were discussed of the limits of natural religion, the proper method of studying it, and the materials accessible for the study. The principal manifestations of natural religion were found to be physical, anthropological, and psychological. The present course is devoted to the consideration of the first of these aspects. Physical religion is defined as a worship of the powers of Nature. The author finds it most completely developed, in its simplest form, in the India of the Vedas; and this leads to a survey of the Vedic literature, the circumstances of its discovery, and its age. The whole process of deification is laid before our eyes in the greatest fullness and most perspicuity in the Vedas. In the hymns grouped under that name we may trace "the gradual and perfectly intelligible development of the predicate God from out of the simplest perceptions and conceptions which the human mind gained from that objective nature by which man found himself surrounded." The name of *deva*, or God, in Sanskrit, meant originally *bright*, and came to mean God after a long process of evolution. Of the many Devas, or Gods, of the Pantheon of the Veda, Agni, or the God of Fire, is selected for an analysis, by means of which the history may be understood "of that long psychological process which, beginning with the simplest and purely material conceptions, has led the mind to that highest concept of duty which we have inherited, together with our language, as members of the great Aryan, and not of the Semitic family." In the lectures succeeding the introduction of Agni, Prof. Müller discusses the biography of the divinity Agni as divested of his material character; the usefulness of the Vedic religion for a comparative study of other religions; fire as conceived in other religions; the mythological development of Agni; Religion, Myth, and Custom; Other Gods of Nature; and the conclusion to which the whole leads—"that the human mind, such as it is, and unassisted by any miracles except the eternal miracles of nature, did arrive at the concept of God in its highest and purest form, did arrive at some of the fundamental doctrines of our own religion. Whatever 'the impregnable rock of Scripture truth' may be, here we have the 'impregnable rock of eternal and universal truth.' 'There is a God above all other gods,' whatever their names, whatever their concepts may have been in the progress of the ages and in the growth of the human mind. Whoever will ponder on that fact, in all its bearings, will discover in time that a comparative study of the religions of the world has lessons to teach us which the study of no single religion by itself can possibly teach."

Appletons' School Physics. By John D. Quackenbos (Literary Editor) and others. New York: American Book Company. Pp. 544. Price, $1.50.

This volume embraces the results of the most recent researches in the several departments of natural philosophy. It is intended to meet a demand for a thoroughly modern text-book on the subject, which shall reflect the most advanced laboratory and pedagogical methods, and at the same time be adapted, in style and matter, for use in the higher grades of our grammar schools, high schools, and academies. In order to secure the best expositions of the several departments of the science, the different sections of the book have been assigned to educators of recognized eminence and skill, especially qualified to deal with the particular topics which are especially given them. Thus, the sections on motion, energy, force, the properties and constitution of matter, solids, liquids, gases, and mechanics proper have been prepared by Prof. S. W. Holman, of the Massachusetts Institute of Technology; those on heat, light, frictional and voltaic electricity, by Prof. Francis E. Nipher, of Washington University, St. Louis; the chapter on sound, by Prof. Alfred M. Mayer, of Stevens Institute; and the sections relating to magnetism and the practical applications of electricity, by Prof. F. B. Crocker, of the Columbia College School of Mines. Among the specific features claimed for the work are the thorough and original treatment of motion, energy, force, and work; and the modern and appliable conception of the nature, transformation, and conservation of energy, and of the relation between energy and force. The book is adapted to students fourteen years old and upward, but, by the omission of certain classes of paragraphs, it may be made comprehensible to younger learners. It has been the aim of the authors not to teach results merely, but to show how these results have been reached, and what practical use is made of them. Precedence is everywhere given to the practical.

The Evolution of Photography. By John Werge. London: Piper & Carter and J. Werge. Pp. 312.

Although photography can now claim a literature of its own, the historical aspect of the art has naturally been neglected. Especially in later years has discovery followed upon discovery so closely as to allow little time for retrospection. The rapid introduction of different processes has been followed by numerous treatises on special methods, and manuals on the general practice of the art abound, but the field of reminiscence has been mostly untrodden save by Mr. Werge, who in 1880 published an account of the origin and process of photography. The present volume easily divides itself into three sections: the first containing an outline of the development of photography; the second, a chronological record; and the third, personal recollections. The author marks four periods in the history of the art: the dark ages; the age of publicity; the epoch of collodion triumphant; the epoch of gelatin successful. The dark ages include the time from the thirteenth century to the advent of the daguerreotype. The first three centuries may be justly regarded as very nebulous indeed, without the glimmering of a photographic ray, and marked only by the discovery of the agents that were long afterward employed in producing pictures. Among such may be counted the invention and perfection of the camera obscura and the metallic researches of the early alchemists. The first step toward acquaintance with actinic influence was the observation of the darkening of chloride of silver in the sixteenth century. As chemical knowledge increased, other phenomena were noted; and finally Scheele, the Swedish chemist, experimented with the prism and demonstrated the greater activity of the violet ray. Meanwhile the double achromatic lens had been constructed, and the possibility of sun portraiture was realized. Scientific men essayed the problem, and in 1839 M. Daguerre's process was given to the world by the French Academy. In spite of this official announcement, there seems to be every reason to agree with Mr. Werge that England had preceded France in photographic discovery, as the Rev. J. B. Reade produced ineffaceable pictures upon paper by means of tannin and hyposulphite of soda in 1837.

The next important advance was made by Talbot in demonstrating the latent image to be the basis of photogenic manipulation. The subsequent discovery and solution of gun-cotton made possible the collodion negatives of Archer; and in 1850, a gelatin process was introduced by M. Poitevin. The art then enters upon its marvelous series of developments; the heliochromes of Niepce de St. Victor, photo-engraving on steel, orthochromatic plates, platinotypes, carbon-printing, and gelatin dry plates. As a dutiful daughter of Science, Photography assists in her researches, makes visible the stars, the mechanism of muscular movement, and the progress of disease.

The chronological record given by Mr. Werge contains not only a list of discoveries and inventions pertaining to photography, but also the bibliography of the art. Some doubt may be justly felt in regard to the dates assigned to the use of iron and glass; a preliminary acquaintance of a thousand years would, however, suffice for the germination of the photographic idea. The recollections and sketches are sprightly, and include many suggestions for artists and amateurs.

The Philosophy of Fiction in Literature. By Daniel Greenleaf Thompson. New York and London: Longmans, Green & Co. Pp. 224. Price, $1.50.

This essay begins with a survey of the office of fiction in literature, estimates its value in the bearings of scientific teaching, morals, and æsthetics, analyzes the qualities of a novel, seeks for its various sources of interest, discusses its relations to art, morals, and science, and closes with observations on the construction and the criticism of a work of fiction. The first quality, underlying all the others, and most essential, of a work of fiction is, that it be of sufficient interest to cause one to read it through. Many and very different qualities may be combined with this interest. Hence we have discussions of the manner and extent to which science, morals, and æsthetics may enter into its scope, and the rival qualities that give the most pronounced distinctions of schools, of realism and idealism. Under the last category we have the important principle that a fiction is a work of art, and must respect the canons of art; it must appeal to the æsthetic sense, never losing sight of that primal condition of artistic work, the elimination of the disagreeable. This and other precepts teach that, in the matter of "naturalism," now so much talked about, "the 'experimental' method is a means, not an end. We must not make the mistake of supposing that the study of Nature consists only in an enumeration of Nature's phenomena. Nor can we impose upon the world by giving it our sketches and studies as the *finale* of art. The use of 'observation and experiment' is to enable us the better to employ our faculties. . . . 'Naturalism' never must be allowed to limit our creative activity, but only minister unto it, chastening it to enable us to give substance rather than shadow. It must not chain genius down. It must not restrict its selection of subjects, nor must it absolutely control its treatment of them. It may lay the foundation, furnish the brick and stone and mortar, but not the architecture of the building." The author agrees with M. David Sauvageot, that the important service has been performed by realism of inaugurating a reaction against the arbitrary conventions of degenerate classic and of romantic art; and that it has prepared the way for a new and dominating idealism. The conclusion is forced that, while realism could not dispense with creativeness, it is, if rightly understood, of great value in making strong, clear, and life-like the products of creation. Other objects of interest and causes of interest considered as giving popularity and success to the story that brings them before the mind are the exhibition of power; the exhibition of love, which "plays so prominent a part in life, has so dominant an influence on conduct, that its absence as a motive is at once felt by the reader, and the plot from which it is omitted seems very artificial"; the exhibition of social life; and the comic or ludicrous element. Important points to be considered by a story-writer are, that he should understand exactly what he is about when he forms the plan of his tale, and should appreciate how far he is appealing to each of the three great interests in a work of fiction, and how far he may disregard one for the sake of the other.

Animal Life and Intelligence. By C. Lloyd Morgan. Boston: Ginn & Co. Pp. 512. Price, $4.

The primary aim of the author of this book has been the consideration of animal intelligence from the scientific and philosophical point of view. He has endeavored to contribute from the results of several years' study and thought to our deeper knowledge of those mental processes which we may fairly infer from the activities of dumb animals. But so inextricably entwined does the subject of intelligence seem to be with the subject of life, the subject of organic evolution with the subject of mental evolution, and so closely questions of natural selection to be interwoven with questions of habit and instinct, that he has devoted the first part of the volume to a consideration of organic evolution. From this consideration the conclusion is reached that the diversity of animal life is the result of processes of evolution or continuity of development. This involves adaptation, which has to be conformed to a changing environment. When the change is in the direction of complexity, we have elaboration; when it is in the direction of simplicity, we have degeneration. Continued elaboration, involving a tendency to differentiation that gives rise to individuality, and a tendency to integration giving rise to association, is progress; and this is opposed to degeneration. The factors of evolution are those of origin and guidance. The origin of variations lies in mechanical stresses and chemical or physical influences. Whether these act on the body, and are transmitted by inheritance, or only on the germ, is not decided. It is also debatable whether use and disuse are factors of origin. The almost universally admitted factor in guidance is natural selection. The physiology of the senses and sense-organs of animals is studied as preliminary to the psychical or mental accompaniments of affections of those organs, which are styled explosive disturbances in the brain or other aggregated mass of nerve-cells. In the mental processes of man a distinction is made between perceptual construction, by which we construct an image of an object from the complex of our perceptions of it, and conceptual analysis, by which we isolate particular qualities of it, forming concepts of the isolates. The formation of a conceptual inference or a judgment is regarded as the first stage of reason, and any mental process involving conceptual inference is rational. In contradistinction to this, an intelligent act is an act performed as the outcome of merely perceptual inference. The quality in animals is intelligence; their faculties are only perceptual. In man alone, and in no other animal, it is contended, is the rational faculty thus defined, developed; and that, "among human folk, that process of natural selection which is so potent a factor in the lower reaches of organic life, sinks into insignificance. For him the moral factor becomes one of the very highest importance. He becomes a conscious participator in the evolution of man, in the progress of humanity." But he can never be wholly independent of natural selection, for biological laws still hold true, though moral considerations and the law of duty may modify them; but, however profound the modification by the introduction of newer and higher factors, the older and lower factors are still at work beneath the surface. The relations of mind and the material organism are discussed in the last chapter.

The Theory of Light. By Thomas Preston, M. A. London and New York: Macmillan & Co. Pp. 465. Price, $3.25.

The history and present condition of the science of optics form the field of this treatise. In his preface the author refers to the difficulty experienced by students of science in obtaining the scattered publications which contain the latest advances in their respective specialties, and states that in no branch of experimental physics is the English student placed at such a disadvantage as in the theory of light. "Influenced by these considerations," he continues, "I have been induced to undertake the present work, with the hope of furnishing the student with an accurate and connected account of the most important optical researches from the earliest times up to the most recent date. I have, however, avoided entering into the more complicated mathematical theories, yet the mathematical theory, in its most elementary form, as well as the experiments on which it is founded, will be found in sufficient detail to enable the student, furnished with the necessary knowledge of higher mathematics, to attack at once with profit the original memoirs and theories recently elaborated by various English and foreign writers." The book gives a few pages to the views of the ancient philosophers, and comes down so far as to include the recent experiments of Prof. Hertz. The divisions of the book, however, are topical rather than historical; thus, the second chapter describes the propagation of light-waves and the composition of vibrations; the rectilinear propagation of light is the subject of the third; and succeeding chapters deal with reflection, refraction, interference, polarization, etc., the topic which concludes the volume being electro-magnetic radiation. The book is supplied with over two hundred diagrams; it is descriptive, not controversial in character, and is adapted to students well advanced in the science.

Heredity, Health, and Personal Beauty. By John V. Shoemaker, M. D. Philadelphia and London: F. A. Davis. Pp. 422. Price, $2.50.

In this book the author presents his subjects in a conversational rather than a formal style, and varies the statement of the scientific principles on which every such treatise must rest with practical directions and illustrative incident. The book can be read with pleasure and amusement as well as with instruction; and if sticklers for form object that in some parts it is hardly dignified enough for science, the author may reply that his book conveys useful knowledge which is none the less knowledge or useful because it is so presented as to be entertaining and easy reading. In the first chapters, which deal with evolution, the Law of Life and Growth, Man's Spiritual and Physical Place in Nature, and kindred topics, are discussed. Weissmann's views on the hereditability of acquired faculties are often referred to, with a disposition to dissent from Weissmann and accept the doctrine of hereditability. The source of the beauty of the fair sex, and the effect of environment and training on the physique, are considered; then the elements of grace, with a chapter on the Art of Walking; the care of the skin and the breath; cosmetic art as applied to the face, hands, feet, hair, and teeth; the care of the eye, ear, and nose; food, clothing, and ventilation; the circulation and digestion; and, in the latter chapters, lists of cosmetic articles, medicated soaps, and household remedies are given.

The Daughter: Her Health, Education, and Wedlock. By William M. Capp, M. D. Philadelphia and London: F. A. Davis. Pp. 144. Price, $1.

The matter of this book was written by special request for a young wife whose education on subjects bearing on her prospective duties as a mother had been insufficient. It furnishes suggestions on subjects of general and obvious interest which might be advantageously worked out in daily home life. Its aim is to enable the mother to second more intelligently the efforts of the medical adviser when he comes professionally into the family, and to offer some practical considerations affecting woman in her family relation. The successive sections of the book treat of the care of the infant from the moment of birth; the child, its training and education; the girl at the age of puberty, and the instruction it is proper to give her then; the wife; and general suggestions upon health.

An Introduction to the Study of Petrology: The Igneous Rocks. By Frederick H. Hatch, F. G. S. Second edition. New York: Macmillan & Co. Pp. 128. Price, 90 cents.

The author has undertaken in this little book to describe briefly the mineral constituents and internal structures of the igneous rocks, their mode of occurrence at the surface, and their origin beneath the crust of the earth. After a few pages of introductory matter, he begins the particular descriptions of the rocks, taking them by groups. Each rock receives a paragraph, in which its chemical composition, crystalline form, hardness, and other characteristics are given, and its mode of occurrence is stated. There is also an extended chapter on the classification and description of the igneous rocks, which gives the distribution of each group in the British Isles. The volume contains forty-three illustrations.

Chapters on the Theory and History of Banking. By Charles F. Dunbar. New York and London: G. P. Putnam's Sons. Pp. 199.

These chapters have been prepared under a feeling of the need of some convenient statement of ordinary banking operations, experienced by the writer when lecturing upon banking to a large class of students in political economy. To the chapters devoted to such operations it was found useful to add a series of historical chapters on certain of the great banks and banking systems. Special chapters have also been added on combined reserves, or the system of clearing-house loan certificates, and the Bank of Amsterdam; and the whole has been revised and the notices of current history have been brought down to the present date.

It is hard to speak too highly of the value of *Appalachia*, the periodical and organ of the *Appalachian Mountain Club*. It serves, in one department of geographical science, a similar purpose with the Proceedings of the Royal Geographical Society, and in an at least equally acceptable manner. Projected with especial reference to promoting the exploration of American mountains, its range has become, without neglecting these, very catholic, and we may now look in it for original studies of mountain structure and scenery and geographical characteristics in all quarters of the world. The second number of Volume VI (December, 1890), for instance, contains accounts of the Ascent of Three Japanese Volcanoes, by W. J. Holland, of the United States Eclipse Expedition, 1887; the Great Smoky Mountains and Thunderhead Peak, by Frank O. Carpenter; the San Juan Mountains, by F. H. Chapin; and An Ascent of Sierra Blanca, by Charles G. Van Brunt. Mr. Holland's and Mr. Chapin's papers are accompanied by illustrations of a high class. W. B. Clark & Co., Boston. Price, 50 cents.

A most welcome aid in the study of English literature, and a charming piece for leisure-hour reading as well, is Sir Philip Sidney's *Defense of Poesy*, otherwise known as *An Apology for Poetry*, which Ginn & Co. publish (price, 90 cents), edited, with introduction and notes, by *Albert S. Cook*. The essay is a masterpiece of English writing, and is replete with noble thoughts expressed in noble style. The apology of fifty-eight pages—hardly too long to be read at a sitting, if one would read fast—is preceded by a sketch of Sidney's life, a discussion of the date of composition and publication, and observations on the author's learning, style, theory of poetry, and followers and imitators, constituting the introduction, and an analysis. The notes give explanations of the allusions in the work and the peculiarities of language and grammar; and are followed by a list of variants in the different editions and an index of proper names.

An edition of the first two extant books of Quintius Curtius (probably the third and fourth books of the original), *Historiarum Alexandri Magni Macedonis*, or Histories of Alexander the Great of Macedon, is published by Ginn & Co. (price, 35 cents), edited for sight-reading by *Harold N. Fowler*. It is intended for the upper classes of preparatory schools and the lower classes of colleges. The editor's principal work has been to supply foot-notes on each page, giving such words and uses of words as the student can not be reasonably expected to be as yet familiar with. In an introduction, Prof. James B. Greenough tells us what sight-reading is, and gives a drill-exercise to teach the student how to proceed to acquire the art. It means to take in the passage and comprehend it without translating it. "A pupil," Prof. Greenough says, "should begin from the start to try to read straight away, as if the language were his own, to see what mental pictures the author meant to present to himself, and only then, if necessary at all, transfer the thought to an English form of expression." This method, he believes, is, in some form or other, consciously or unconsciously, indispensable for any real knowledge of a foreign tongue.

Contributions to the History of the Southwestern Portion of the United States is the fourth substantial volume, besides a number of essays and statements, included in the annual reports which the Archæological Institute of America has published of the work of Mr. *A. F. Bandelier*. It appears as one of the papers of the Hemenway Southwestern Archæological Expedition. The volume includes an introductory sketch of the knowledge which the Spaniards in Mexico possessed of the countries north of the province of New Galicia, previous to the return of Cabeza de Vaca, in 1536; with papers on Cabeza de Vaca and the importance of his wanderings for Spanish explorations toward New Mexico and Arizona; Spanish efforts to penetrate to the north of Sinaloa, between 1536 and 1539; Fray Marcos of Nizza; and the expedition of Piedro de Villazur, from Santa Fé to the banks of the Platte River in 1720. It was the author's plan, treating the history of the Southwest in sections, monographically, to publish papers further on the expeditions of Coronada, Chamuscado, Espejo, and Oñate, but a suspension of the enterprise is at present forced upon him; and he intimates that there is material to be found in Spain which has not yet been examined that would contribute to the completeness of the work.

Mr. H. L. Green, of the *Freethinker's Magazine*, has sent us a bundle of pamphlets on subjects in which freethinkers are interested, or the thought of which is in accord with that of the school described under that name. It includes two pamphlets on Giordano Bruno and his Monument, containing half a dozen papers by as many authors, and representations of the monument as originally designed and as erected; Ingersoll's Centennial Oration on the Declaration of Independence and Memorial Oration on Roscoe Conkling; The Myth of the Great Deluge, by James M. McCann; Church and State; and a statement of What constitutes a Freethinker? by Mr. Green. The last presents several points of interest. Freethinkers, we learn, "have no war with the Bible—they should have no prejudices against it"; but they are disposed to regard it as like other books, and to decline to accept it, on trust, at the value at which Christians hold it. The author contends that his best and safest friend in matters of religion is reason, and holds everything subject to investigation. "But, notwithstanding the freethinker rejects the Christian view of the Bible and religion, he is an earnest advocate of certain views and opinions of his own. He accepts the truth wherever found. For this reason, although he rejects the claim made for the Bible and religion, he accepts whatever is true or good in either."

In *The Death Penalty* (Putnam's Questions of the Day Series, price $1.50) Mr. *Andrew J. Palm* presents, in rather an impassioned manner, the principal objections to capital punishment. He holds that it is essentially cruel; and that justice as well as mercy should make great allowance for human conduct. He puts aside the Bible argument as not bearing upon the relations of capital punishment to society at the present time; dwells upon the capriciousness of juries, the perils of convicting the innocent, and the harshness of treating the insane as if they were criminals; holds up the detestation with which the executioner is regarded as evidence that the death penalty is repulsive to the better feelings of men; shows how inadequate is fear of the death penalty to repress crime; cites "the voice of experience" — of states which have abolished capital punishment—as being on his side; and quotes the opinions of some noted men on the subject. He then pleads for the reformatory theory of treatment; and closes with a chapter on war.

The compact little work on *Mixed Metals or Metallic Alloys*, by *Arthur H. Hiorns* (Macmillan, $1.50), gives the composition and mode of making a great number of alloys, and in some cases describes the apparatus used in producing them. The author, who is principal of the School of Metallurgy in the Birmingham and Midland Institute, states that his book is designed to give practical men and students a more intimate acquaintance with the nature and properties of metals in the alloyed state, as well as with metals in the free state. The first portion deals with the principal chemical elements, and their classification into suitable groups; the refractory materials used in making crucibles and in furnace construction; as well as the properties and uses of various fluxes. "It has been thought advisable to give a brief account of the main properties of the separate metals, and of the effect of certain elements upon them, seeing that commercial metals are not chemically pure substances, and that the presence of the common impurities often produces a characteristic result, which may be a useful guide to the manufacturer in special cases, and assist him to determine the cause of those anomalies which are constantly occurring in practice."

A manual for medical students and physicians, on *The Physical Diagnosis of the Diseases of the Heart and Lungs*, has been published by Dr. *D. M. Cammann* (Putnams, $1.25). Some topics in this field which have especially interested the author, or on which a reasonable difference of opinion exists, have been considered more in detail than is usual in such a work. In particular the author has improved this opportunity to explain at length his modification of the Cammann stethoscope and the binaural hydrophone. The volume contains twenty-two figures.

A great deal of material is compressed into a small compass in the *Lessons in Applied Mechanics*, by *James H. Cotterill* and *John Henry Slade* (Macmillan, $1.25). The volume is a text-book consisting largely of matter contained in a more extended treatise by the senior author. The chapters are grouped under three heads: Part I, The Principle of Work, includes the subjects of motion, friction, work and energy, the operation of simple machines, the direct-acting engine, unbalanced forces, and dynamometers. Part II deals with Strength of Materials and

Structures; and two chapters on Hydraulics constitute Part III. A list of examples follows each chapter, the total number being over 250, and there are 377 diagrams in the text.

Under the title *Cotton Facts*, a compilation of statistics is published by *Alfred B. Shepperson* (New York), relating to the crops, receipts, exports, stocks, home and foreign consumption, visible supply, prices and acreage of cotton for a series of years, and other related matters. The present edition of the book continues to the close of the cotton season of 1889–'90 the statistics contained in previous issues. Besides the tables, there are several special articles in the volume, one being on Cotton Culture in Central Asia, by Henry G. Kittredge, editor of the Journal of Commerce, Boston, and others on the Cotton Caterpillar, and the Cotton Season of 1889–'90.

The purpose carried out in *Christ and Our Country*, by Rev. *John B. Robins* (Farnesworth Bros., Dalton, Ga., 75 cents), is to combat some of the apprehensions expressed in Our Country, by Dr. Josiah Strong, and Modern Cities, by Samuel L. Loomis. The author has strong hope that Christianity will counteract the dangers that these authors discern in immigration, increasing wealth, Romanism, Mormonism, socialism, city life, etc.

A volume of satire in verse, entitled *The Devil's Visit*, has just appeared, without the author's name (Excelsior Publishing House, $1). A marvelous variety of topics is touched upon in this book, ranging from practical politics to the teaching of Greek, and from communism to the deceptions of a woman's toilet. Every reader will find the faults and follies of many people he knows sharply touched up, and, if he only succeeds in skipping the part where his own weaknesses are similarly treated, will doubtless get much enjoyment from the volume.

The American Patent System, by *D. Walter Brown* (the author, New York), is a manual of direction and advice for inventors in regard to obtaining patents, and in correcting and transferring them.

We have received from Brentano's a fancifully got up volume entitled *Gentlemen*, and divided into two parts, treating respectively of dress and "essential customs" for gentlemen. From the former part we learn that the monocle "is worn any time of day," and in the latter we are informed that no gentleman should ask for a lady's picture "without first having met her at least seven times." These quotations sufficiently indicate the nature of the book. (Price $1.50.)

With its first number for the current year, *The Teacher* began a new series, and added several elements of strength to its already high character. Mrs. *Mary Hargrove Simpson* remains the general editor, and now has as associates the following well-known educators: Louisa P. Hopkins, of Boston; Ellen E. Kenyon and Caroline B. Le Row, of Brooklyn; W. N. Hailmann, of La Porte, Ind.; B. A. Hinsdale, of Ann Arbor; H. M. Leipziger, of New York; and C. M. Woodward, of St. Louis. This journal has been from the start an exponent of advanced modern thought in the domain of education. Its special purpose is to set forth the scientific principles on which the art of teaching is coming more and more to depend, and the working out of which every teacher and school officer must keep track of, if he wishes to keep up with the progress of the time in his profession. The departments of *The Teacher* are Editorial and Miscellaneous, Theory and Practice of Teaching, Correspondence, Reviews, and Notes. Its articles have the character expected in magazine articles, and it may be questioned whether the nature of the journal would not be better indicated if it should adopt the magazine form. (The Teacher Co., New York. $1 a year.)

PUBLICATIONS RECEIVED.

Abbott, Francis A. The Scientific Method. Appletons. Pp. 27. 10 cents.

Adler, Mrs. Helen. Scientific Observation and Study of Children. New York: The Teacher Co. Pp. 15.

Agricultural Experiment Stations: Connecticut. Bulletins on Cedar Apples. Pp. 6.—Cornell University. Egg Plants. Pp. 26.—Iowa Bulletin No. 12. Various Papers. Pp 56.—Massachusetts. Annual Report. Pp. 324.—Mississippi. Injurious Insects. Pp. 41.—Nebraska Sugar-Beet Series, No. II. Pp. 98.—New York. Laying Hens. Pp. 16; Coarse Foods. Pp. 10.—Storrs, Conn. Third Annual Report. Pp. 200.

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Aveling, Edward. Introduction to the Study of Botany. Macmillan. Pp. 363. $1.10.

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Caillard, E. M. Electricity the Science of the Nineteenth Century. Appletons. Pp. 310. $1.25.

Campbell, Levin H. The Patent System of the United States. Washington. Pp. 55.

Cheritree, Olive E. Evolution. Pp. 96.

Comegys, Benjamin B. Primer of Ethics. Boston: Ginn & Co. Pp. 127.

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Dole, Charles F. The American Citizen. Boston. D. C. Heath & Co. Pp. 320.

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Griswold, W. M. Descriptive List of Novels and Tales dealing with American City Life. Cambridge, Mass. Pp. 100.

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Winchell, N. H., and H. V. Iron Ores of Minnesota. Minneapolis. Pp. 429, with Plates and Maps.

World's Office Diary, Monthly. English and Spanish. Times Building, New York. Pp. 100. 50 cents.

Wright, Lewis. Optical Projection. Longmans, Green & Co. Pp. 426. $2.25.

POPULAR MISCELLANY.

The First Piece of American Hollow Ware.—In the first of Mr. Durfee's series of articles on Early Steps in Iron-making, in The Popular Science Monthly for December, 1890, "a small iron pot capable of con-

taining about one quart," which was cast at Lynn, Mass., in 1645, was mentioned as having been the first piece of hollow ware made in America. Mr. Durfee added that "this pioneer of all American-made castings was in existence in 1844, but recent efforts [by C. H. J. Woodbury] to ascertain its whereabouts have been unsuccessful." We are informed by the Lynn Daily Item that Mr. Durfee's article attracted the attention of F. W. Pope, of Lynn, who happened to have recently seen the pot, and made a photographic picture of it. We give an engraving of it. The pot is in the possession of the sons of Alonzo Lewis, the historian and poet, whose description of the Saugus Iron Works is quoted by Mr. Durfee. It is an heirloom, having descended to the present owners through their father from "Thomas Hudson, of Linne," the original possessor. It holds less than a quart, and weighs two pounds thirteen ounces. When photographed by Mr. Pope, it was standing on a common tea-plate; and there was room enough on the flat bottom of the plate to accommodate its spreading legs and leave an ample border of flat around them.

Metal Railway Ties.—A large share, probably twenty per cent, of the timber cut in this country is used by the railroads, and an important item in this portion is the quantity used for ties. With the purpose of lessening the drain upon our forest resources, the Forestry Division of the Department of Agriculture is endeavoring to lead the railroads to substitute iron ties for wood. A Report on the Substitution of Metal for Wood in Railroad Ties, made by E. E. Russell Tratman, has been published by the department, in order to furnish the companies with information in regard to the use of iron ties, and thereby facilitate their general adoption. The report is introduced by A Discussion on Practicable Economies in the Use of Wood for Railway Purposes, by B. E. Fernow, Chief of the Forestry Division, in which suggestions are given as to seasoning and preserving wooden ties, the use of improved tie plates, and also in regard to the use of stone and metal for buildings, bridges, etc., of hedges for fencing, and of metal for rolling stock. The report of Mr. Tratman gives detailed information respecting the use of different systems of iron ties in all quarters of the world. Outside of the United States and Canada there are reported 25,000 miles of railroad laid with metal ties. The most in any one country is in British India, where there are over 9,000 miles; Germany has nearly as much; and the Argentine Republic is third, with 3,500. In the United States, with a total mileage of 161,000, or four ninths of the whole mileage of the world, there are only two miles of metal track. Egypt has nearly 900 miles, and the rest of Africa makes up 400 miles more. In little Holland there are 329 miles, and Switzerland has 397. Allowing for incomplete returns, Mr. Tratman estimates that (exclusive of the United States and Canada) nearly sixteen per cent of the mileage of the world is laid with metal ties, and the use of metal is being extended. Hence, abroad the subject has long ago passed the experimental stage in which it rests in this country. The report contains descriptions of all the most practicable forms of metal ties that have been invented, and a list of all the United States patents relating to metal railway track, numbering 491. The first of these dates from 1839, and the second from 1850. Patents have also been granted for cross-ties or track of clay, concrete, etc., and one for glass ties.

The Tin Soldiers of Nuremberg.—The artists of Nuremberg and Fürth have long been famous for their manufactures of toy-soldiers of lead. The art dates from the Seven Years' War, and was developed under the influence of the enthusiasm aroused by the career of Frederick the Great. Much pains are taken with the sketches of the intended figures, and eminent artists are willing to supply the models. Certain fixed rules have to be adhered to in designing the figures. In colors, deep tints must be avoided, and gaudy hues preferred. The artists must be acquainted with the military costumes of the period to which the soldier they represent belonged. Anachronisms in this matter are fatal. Molds of slate are used for the plain figures, and of brass for those in relief. The figures, having been cast, are taken out and trimmed; then handed over to the women, to be painted; and then to other women, to be packed in wooden boxes.

Rotten Logs as Breeders of Borers.—A newly noticed evil resulting from mismanagement in forest affairs has been pointed out in Garden and Forest by Prof. Fernow. It comes from leaving large parts of felled trees on the ground and allowing fires to run through the woods, by which the multiplication of borers and other mischievous insects is promoted. A large proportion of the beetle larvæ which infest living trees can not exist in a thoroughly healthy and vigorously growing tree; those larvæ in particular which are found in the cambium layer between the wood and the bark would be drowned in the sap of healthy trees. They are, therefore, mostly found in those trees which, for some reason or other, are less vigorous or on the road to decay. When a fire has run through the pine forest, or when the leaf-destroying caterpillar has ravaged the foliage and thus reduced the vigor of the trees, these beetles find a most favorable breeding-place in the weakened trees, and their larvæ multiply rapidly and finish the work of destruction in a short time. For this reason it is often necessary to cut millions of feet of timber or cord-wood at once, or it will be entirely ruined. The frequent forest fires and the failure of the farmer and lumberman in disposing of large parts of the felled trees must be considered as among the principal causes of the prevalence in North America of these insect borers. The flat-head borer of the orchards, the oak pruner, grape borers, a blackberry borer, the apple-twig borer, and several bark borers are mentioned as among the insects the growth of which is encouraged by the prevalence of dead timber.

A Torres Strait Decalogue.—Among the western islanders of Torres Straite, boys, as soon as the approach of maturity is indicated by the appearance of hair on their faces, are taken by their fathers to a sacred spot and there instructed in the duties and dignity of manhood. A number of precepts which are taught during this probation have been collected and are published by Prof. Alfred C. Haddon. Among them are these:

"You no steal."

"If you see food belong another man, you no take it, or you dead."

"You no take thing belong another man without leave; if you see a fish-spear and take it, s'pose you break it and you no got spear, how you pay man?"

"S'pose you see a dugong-harpoon in a canoe and take it, he no savvy, then you lose it or break it, how you pay him? You no got dugong-harpoon."

"You no play with boy and girl now; you a man now, and no boy."

"You no play with small play-canoe, or with toy-spear; that all finish now."

"You no like girl first; if you do, the girl laugh at you and call you a woman." (That is, the young man must not propose marriage to a girl, but must wait for her to ask first.)

"You no marry the sister of your mate, or by and by you will be ashamed; mates all same as brothers." (But "mates" may marry two sisters.)

"You no marry your cousin; she all same as sister."

"If any one asks for food, or water, or anything, you give something; if you have a little, give a little; if you have plenty, give half."

"Look after your mother and father; never mind if you and your wife go without."

"Don't speak bad word to mother."

"Give half of all your fish to your parents; don't be mean."

"Father and mother all along same as food in belly; when they die you feel hungry and empty."

"Mind your uncles, too, and cousins."

"If woman walk along, you no follow; by and by man look, he call you bad name."

"If a canoe is going to another place, you go in canoe; no stop behind to steal woman."

"If your brother is going out to fight, you help him; don't let him go first, but go together."

A Glacial Epoch in the Carboniferous Period.—Data are collated by Dr. C. D. White, in a paper published in the American Geologist, on Carboniferous Glaciation in the Southern and Eastern Hemispheres—based on observations in India, Australia, and South Africa—which show that evidences of glacial action are abundant and marked within an area extending from 40° south latitude to 35° north, and from 20° east longitude to 155° east, and including more than one fourth of the earth's surface. The idea that there was a glacial epoch in later Palæozoic or earliest Mesozoic time has, in the light of these evidences, gained credence steadily since 1872, "until at last it is supported, not only officially, but individually," by nearly every geologist who has specially examined them or studied them in the field. This is also the conclusion generally accepted by European geologists, including Prestwich and Neumayr, who is quoted as saying, in his Erdgeschichte, that there can no longer be any doubt that during the latter half of the Carboniferous period strata were deposited in southern Australia, Farther India, and the Cape region of South Africa, whose material shows all the characteristic features of transportation by means of glaciers.

Packing Fruit for Transportation.—The instructions of the British Pomological Society respecting the packing of fruit for transportation advise that, for protection against injury from pressure, it be put up in boxes or stout baskets; against shaking, by using cases of moderate dimensions in every direction, or cases cut up by partitions, and by laying the separate articles so closely and compactly that they shall just keep each other steady without crushing. Packing material which might communicate an unpleasant flavor should not be used. The bloom of fruits is best preserved when they are packed in young nettle-tops, partly dried, or in cartridge-paper. Grapes carry best if tied down to the bottom of a shallow box, or when each bunch is inclosed separately in a piece of stout cartridge-paper. Melons should be inclosed in cap paper, placed in a box, and surrounded by chaff, bran, or dry sawdust. Peaches, nectarines, and apricots should be carefully inclosed in a piece of tissue-paper, and kept separate from one another by cotton-wool. Plums, when the bloom is important, should be rolled up, six or eight together, in a piece of cartridge-paper, and tied round with matting. When the bloom is not important, they may be packed in strawberry or similar leaves. Cherries, gooseberries, and currants travel very well, under general circumstances, if laid together in small, shallow baskets or punnets. In packing strawberries, raspberries, and mulberries, each fruit should be separately surrounded by one or two strawberry leaves.

The Care of Milk and Cream.—In milk and cream exposed to the air, bacteria readily collect and multiply rapidly. They cause the souring and curdling of milk and induce other changes in it, while their effect on cream is to aid its "ripening." Dairymen let their cream ripen before churning, because their experience shows that from such cream butter "comes" more readily, keeps better, and is of better flavor than from sweet cream. In a recent paper on this subject, Dr. H. W. Conn states that milk will become contaminated with bacteria if put into vessels in which particles of curd and grease are left sticking in joints and on the sides. Boiling in water will kill the bacteria, but their spores or seeds can not be killed without a higher heat. Hence, to prevent the souring of milk, cans and pans should be set on a stove or in the oven a few minutes after washing. As cold checks the development of bacteria, the milk should be cooled immediately after it is drawn from the cow, and kept as cool as possible. Cream for butter, on the contrary, should be kept in a warm place, so as to favor the growth of bacteria. Dairymen sometimes add a little old cream to a fresh lot as a leaven. Acid is also added for the same purpose, but this is of doubtful use.

A Fire-ball in Art.—In the Madonna painted by Raphael for Sigismondo dei Conti dal Foligno, the Virgin is represented as in the clouds, the clouds rest upon a rainbow, and under the bow is a red fire-ball. Assuming that the introduction of so unique a feature as a fire-ball in a painting of the Madonna is symbolic, Prof. H. A. Newton has inquired into the history of the subject. He finds that on the 4th of September, 1511, there fell near Crema, some leagues southeast of Milan, a number of stones, the results of the explosion of a meteorite, which are described by several authors; and he believes that Raphael intended to represent this aërolite in his painting. He seeks to interpret its meaning by finding what men thought of such phenomena. When the Ensisheim stone fell, nineteen years earlier than this one, near the lines separating the contending French and German forces, the Emperor Maximilian had the stone brought up to the castle, and held a council of state to consider what the fall meant. Sebastian Brant, in a poem describing the fall, speaks of the terror it caused to the Burgundians and French. Eleven years later, in 1503, Maximilian, in a proclamation appealing for aid, included the Ensisheim stone-fall among indications of divine favor. After the fall of 1511, although the papal forces were defeated in battle, the French were forced to withdraw in June, 1512, from Milan and northern Italy. It is natural, then, to suppose that Raphael in the picture united in his painting the fire-ball with the rainbow in order to symbolize divine reconciliation and assistance.

The Highest Mexican Volcano.—One of the results of the recent scientific expedition of Prof. Angelo Heilprin and his companions to Mexico was the establishment of Orizaba as the highest of the giant volcanoes of that country. The barometrical measurements of the four highest volcanoes gave for Orizaba, 18,205 feet; Popocatepetl, 17,523 feet; Iztaccihuatl, 16,960 feet; and Nevado de Toluca, 14,954 feet. In favor of the accuracy of the measurements, Prof. Heilprin refers to the quality of his registered aneroid barometer, which was tested and corrected at Philadelphia before and after starting, at Vera Cruz, and in the city of Mexico; and the fact that all the summits were ascended within three weeks, and were measured with the same instrument, during a period of atmospheric equability and stability which is offered to an unusual degree by a tropical dry season. The measurements bring up the question of what is the culminating point of the North American continent. The only other mountain than Orizaba that need be considered in this connection is Mount St. Elias, in Alaska. The measurements of this mountain, however, depart so widely from one another that we are not yet in a position to affirm, even within limits of a thousand feet or more, how nearly it approaches in height the Mexican volcanoes. The most usual figure in standard publications is 14,970 feet; Malespina found, by taking the angles from Port Mulgrave, 17,851 feet, Tebenkoff reduced this figure by somewhat more than 900 feet. Mr. Dall, in 1874, made angular measurements from four points, 69, 127, 132, and 167 miles away, that gave results varying from 18,033 to 19,596 feet. He does not place great confidence in any of them. In view of the broad divergence existing in the later measurements, and the fact that all earlier determinations give less than 18,000 feet for the height of Mount St. Elias, Prof. Heilprin intimates that "geographers will probably consider the question of absolute height as still an open one. That the mountain closely approximates the giants of the Mexican plateau is almost certain, but it seems equally probable that its true position is after, and not before, the Peak of Orizaba."

Bulgarian House Communities. — The Bulgarian house communities, according to Mr. J. E. Gueshov, called there *kupshtina*, are very like the *zadrugas* of the Serbs and Croats. The head of the society is called *domakin*, the man of the house, and is usually either married or a widower, but may be a single man. The *domakina*, or lady of the house, is generally the wife of the *domakin*, or the widow of a previous one, or, if there be no such person, the oldest woman of the community is elected to the place. She regulates the work to be done by the women of the household; as, for instance, who is to bake or cook on particular days; and she arranges the domestic labor so as to allow the women time for attention to their children and to other duties. The principle of the community is that each member must work according to his capacity, for the common good. Any one who is dissatisfied with the work assigned to him can leave the community, but the only goods which he is allowed to carry away as his own are his clothes. If one of the women contracts a second marriage with a man who is not a member of the community, her children by her first husband remain in the society, although she herself quits it. When the girls marry, they receive nothing from the community, except a *zestra* of clothes and bed-furniture, for which the bridegroom makes a money payment. These house communities are spread over Bulgaria from Leskovatz on the north to Macedonia. Details are given by Mr. Gueshov of the community of Gornya-Banga, not far from Sofia. Its head is a priest. Some four years ago it consisted of twenty-eight and thirty-five members. With the *domakin*, Todorin, work his six brothers, one of whom is a priest, the second a farmer, the third a shepherd, a fourth the keeper of an inn, and another a tailor. No property is private among them except their clothes. All work for the house community; even the priest, if he gets money from any quarter, from a wedding, christening, or funeral, is obliged to bring it into the common fund. The *domakina*, the wife of Todorin, arranges which of her sisters-in-law shall bake one day and which shall cook. One oven and one kettle suffice for all. Concord and love prevail in the community; and the priest assured Mr. Gueshov that, if they had possessed in severalty, they could never have passed through the terrible period of the last Russo-Turkish War. No legal sanction has been given since the independence of Bulgaria to this customary right, but it remains deeply rooted as an institution in the public mind. A case is told of a member of a community who bought two plots of land and secured a confirmation from a court of law of his property in them. The whole village rose against him, and he was obliged to hand the plots over to the society to be common property. There are also co-operative market gardeners in Bulgaria, who travel about and raise vegetables on plots which they hire. The unit of the gardeners' co-operative society is the working gardener. If a man has gained experience in this calling, he can easily enter one of them, even if he has no money. The union, called a *taifa*, is great or little according to the size of the garden which it is proposed to cultivate, and that of the town which offers a market for their products. The largest shareholders are the master, who holds the purse and keeps the accounts, and the salesman; but the funds of the society are distributed in proportion among the workers in the garden. Other co-operative societies exist among shepherds, reapers, masons, bakers, tinkers, and potters.

Good and Bad Novels.—Whatever influence novels have upon the mind of a reader is due to giving him a wider acquaintance than his own experience affords with life, or what passes for life. Novels deal only with the interesting parts of life, leaving out of sight the commonplace matters which make up more than three fourths of real life, otherwise they would not be read. Good novels represent these interesting features as they are, and give the real feelings of honorable men and women toward the actions and occurrences which make up the story. Bad novels, on the contrary, make their readers believe themselves and others to be what they are not, disturb their judgments, and fill them with false hopes as to what they may expect at the hands of destiny. Novels impel their readers to pursue the thoughts and foster the emotions of the accomplished or smart heroes and heroines whom they have been led to admire. When these thoughts and emotions are pure, generous, and elevated, fiction becomes an agent for good; but when its model characters are willful, pompous, immoral, and impossibly successful withal, its effect is deplorably degrading.

Sanitary Entombment.—Entombment, or deposition in a mausoleum, is represented, by the Rev. Charles R. Treat, as the mode of disposing of the dead to which the human race, as a whole, has shown the most evident preference. Sanitary entombment is described by him as comprising this feature combined with desiccation, a process which is performed naturally in some atmospheres, and which the author believes can be made artificially practicable, with entombment, everywhere. He proposes, therefore, the arrangement, in buildings like the "Campo Santo" of Pisa, of sepulchres "so constructed that anhydrous air could enter or be made to enter, and withdraw, laden with moisture and morbific matter, which it would convey to a separate structure, where a furnace would complete the sanitary work that the anhydrous air had begun, and return to the external atmosphere nothing that would be noxious." This would retain the form and much of the substance of the body, and subject the noxious, volatile particles to cremation.

Conditions of Vigorous Old Age.—The present greater proportion than formerly existed of men who pass the age of seventy years, reach fourscore, or are active at ninety years, points to one of the brighter phases of our civilization. The association of this vigor with different physical types is suggestive of a certain generality of origin, and encourages the hope that it may be partly dependent on personal conduct. As a first condition toward obtaining effective longevity, Dr. B. W. Richardson advises parents to begin for their children by saving them the infliction of mental shocks and unnecessary grief, and making everything as happy for them as they can. The persons themselves, when older, should avoid grief and eschew hate, jealousy, unchastity, and intemperance, all of which hasten the coming of old age. When old age has really begun, its march may be delayed by rules securing the least friction and the least waste: subsistence on light but nutritious food, varying according to the season, and moderate in quantity; dressing warmly, but lightly, so as to enable the body to maintain its even temperature; keeping the body in fair exercise and the mind active and cheerful; maintaining an interest in what is going on in the world, and participating in reasonable labors and pleasures; securing plenty of sleep during sleeping hours, in a room kept at a moderate temperature; and avoiding passion, excitement, and luxury. The weaker man may thus sometimes show himself the more tenacious of life.

The Chartreuse Liquor.—The Chartreuse liquor is made under the direction of the monks of the abbey of the Grand Chartreuse, in the high Alps of Dauphiny. This abbey is the headquarters of the Carthusian order, which has some fifteen houses in France, Italy, Switzerland, and Austria. The manufacture is carried on by paid operatives, under the supervision of the abbey steward, while the rest of the monks have no concern with it. The population of the village are employed in collecting the herbs, which, mixed with *eau-de-vie*, are distilled along with the spirit. This brandy is purchased, not made at the abbey. Only one of the operations—the mixture of the herbs—is a secret. The manufacture of Chartreuse as a market product has grown up since 1835. Previous to that time it was made only on a small scale as a remedy. There were formerly three kinds of Chartreuse made, the white, yellow, and green; but the white has been abandoned. The green is the strongest and most expensive; and the monks recommend a mixture of one third green and two thirds yellow as the best. A Chartreuse is made at the Certosa, near Florence, by a few lingering Carthusians of the old society, whose secret is likely to perish with them. The Dominicans of Santa Maria Novella formerly manufactured elixirs and scents, but, according to Chambers's Journal, have been broken up by the Government. The Benedictines make a rival to Chartreuse; and the monks of Tre Fontane, near Rome, make a "Eucalyptica," with *Eucalyptus;* but Chartreuse continues to enjoy the higher esteem.

The Massachusetts Institute of Technology.—The twenty-fifth anniversary of this highly respected school occurred in 1890, and was commemorated by an address reviewing the career of the institution, which was delivered by Augustus Lowell. The Institute was founded by the eminent geologist, Prof. William B. Rogers. The work of organization was retarded by the civil war, but in February, 1865, the school opened with twenty-seven students. In 1872 the number had increased to three hundred and forty-eight, and then came the financial crisis, which very nearly wrecked the undertaking. It survived, however, and the revival of business brought it a new era of prosperity, so that its students now number nine hundred, with ninety instructors and eleven courses of study. The purpose of the Institute of Technology is to prepare men to direct those great industrial enterprises and public works which require a thorough training, based upon an adequate acquaintance with science, for their successful prosecution. Additions to the facilities of the school have been made in rapid succession, often looking to the future to supply the requisite means. This institution was one of the first in the world to instruct chemistry classes by the laboratory method. Its first chemical instructors were Charles W. Eliot, now President of Harvard, and Prof. Frank H. Storer. A physical laboratory was established at about the same time. In 1871 a laboratory for the course in mining engineering was begun, by the purchase of apparatus in which economic quantities of ores could be treated. Two years later a sixteen-horse-power engine, with apparatus for engine and boiler tests, was provided. In 1881 a laboratory of applied mechanics, devoted especially to tests of building materials, was added. A distinct course in electrical engineering was organized in 1882, and this study had its special laboratory fitted up in the new building which the growth of the school required to be erected in the following year. Six years later another new building was put up, and during all these years delicate instruments and powerful machines of great variety have been continually added to the equipment of all departments. In carrying on its work the Institute has several times incurred heavy debts, most of which have been canceled by the efforts of its friends. It still owes, however, the cost of its latest building ($120,000). The graduates that it has been sending out for over twenty years are doing valuable work in the several engineering professions, and as instructors in various departments of science and technology, while the example of the Institute has done much to extend the laboratory method of science-teaching.

The Nature of a Flash of Lightning.—Describing the electric discharge of a flash of lightning, Prof. Oliver J. Lodge compares the cloud and the earth as forming the two coats of a Leyden jar, in the dielectrics of which houses and people exist. The occurrence of the discharge is determined at the moment when the maximum electric tension which the air can stand is reached. "At whatever point the electric tension rises to this value, smash goes the air. The breakage need not amount to a flash; it must give way along a great length to cause a flash; if the break is only local, nothing more than a brush or fizz may be seen. But when a flash does occur, it must be the weakest spot that gives way first—the place of maximum tension—and this is commonly on the smallest knob or surface which rears itself into the space between the dielectrics. If there be a number of small knobs or points, the glows and brushes become so numerous that the tension is greatly relieved, and the whole of a moderate thunder-cloud might be discharged in this way without the least violence. This is by far the best way of protecting anything from lightning: do not let the lightning-flash occur if you can possibly avoid it. But one can not always prevent it, even by a myriad points. A good deal more might be done in this direction than is done; but still, sometimes a cloud will descend so quickly, or it will have such a tremendous store of energy to get rid of, that no points are sufficiently rapid for the work, and crash it all comes at once." Where a flash occurs, a considerable area is relieved of strain, and the rush of electricity along the cloud and along the ground toward the line of flash sets up a state of things very encouraging to another or secondary flash or flashes, practically simultaneous with the first.

Weather Plants.—Garden and Forest quotes from a writer in the *Illustrirte Gartenzeitung* of Vienna, who, while he disputes the excessive claims that have been made for certain "weather plants," points out that a modest degree of power in forecasting atmospheric changes is possessed by a multitude of common plants. The pleasant fair-weather odor of *Galium vernum* (Our Lady's bed-straw) becomes strong and pungent at the approach of rain. The leaves of *Carlina vulgaris* close before rain. *Calendula pluvialis* (marigold) predicts rain when its flowers remain closed after seven in the morning. *Oxalis acetosella* (wood-sorrel) closes its leaves at the approach of rain or cold. *Lapsana communis* keeps its flowers open at evening if it is to rain the following day, but closes them if fair weather is coming. The leaves of *Draba verna* (whitlow-grass) droop before rain. *Alsine media* predicts a clear day if its flowers open about nine o'clock, and a second one to follow if they remain open as late as four in the afternoon.

A Novel Mound-builders' Structure.—Prof. F. W. Putnam described, at the meeting of the American Association, a curious earthwork at Foster's Station, in the Little Miami Valley. The mound is in the angle of a creek and the river. It is a flat-topped circular hill, about half a mile round at the rim, and has been formed by the river and creek washing away drift material on either side. Around the brow of this hill is, at some parts, a ridge, at others no elevation above the surface. The ridge is made up of well-burned clay, and includes masses of burned limestone, clinkers, charred logs, and heaps of ashes, from a bushel to forty bushels in bulk. It is more than half a mile long, from twenty to fifty feet wide, and from eight to ten feet deep. To have burned all this clay must have required a heat like that of a Bessemer furnace. The rim of burned stuff is backed by an escarpment of well-laid stone wall to keep the burned material in place, which probably once extended clear down to the water; but the creek has worn its way down and to a considerable distance from the wall. No bones and only a few pieces of pottery were found. The fires could not have been those of charcoal-pits, and the place was not a limekiln. An immense mass of fuel must have been collected to burn this quantity of clay and stone. When asked what he thought was the character of the work, Prof. Putnam said that he had not carried the excavations far enough to formulate a statement.

NOTES.

The Hon. David A. Wells has been awarded a gold medal by the jury of the group of Social and Political Economics of the French Exhibition of 1889. This recognition of the great services he has rendered in that branch is all the more significant because it comes to him, a plain-spoken free-trader, from a leading protectionist nation.

One of the subjects touched upon by Dr. Fernow, in his Forestry Report for 1889, is osier culture. Of the many kinds of willows, but few are osier willows fit for basket-work. Some coarse baskets are made from our native willows. For better work, one of the European kinds—the red osier—is grown in this country, but the finest baskets are almost wholly imported. A large number of the hands employed in the salt-works around Syracuse in summer occupy their winters with basket-making. In 1887 Dr. Fernow obtained from an Austrian grower cuttings from some seventy varieties of osiers, which were distributed to the agricultural experiment stations. Some information has thus been gained in regard to the growth of these plants in our climate, but further trials are still needed.

The first rain-gauge, according to Mr. G. J. Symons, was designed by Sir Christopher Wren in 1663. Sir Christopher also designed the first recording gauge, but the instrument was not constructed till 1670. The earliest known records of rainfall were made at Paris, in 1668; Townley, Lancashire, in 1677; Zurich, in 1708; and Londonderry, in 1711.

In an address before the Medical Society of Pennsylvania, Dr. Thomas J. Mays presents evidence for doubting the view that consumption is contagious, and closes by saying that "never was an *ignis fatuus* pursued which left more promises broken and greater anticipations unfulfilled than the bacillus theory, so far as it stands related to the prevention and treatment of pulmonary consumption."

M. Moissan has detected free native fluorine in the fluor-spar of the variegated vein that occurs in the syenite of Guinchay, near Lyons. He and M. Henri Becquerel have ascertained that the mineral on being crushed exhales a pronounced odor, something like that of chlorine, but more like the odor of fluorine. The gas thus disengaged displaces the iodine in iodide of potassium, so that starch is turned blue on contact with it; and it retains this property after the stone has been heated to 200° C.—a temperature at which ozone, to which the action might otherwise be attributed, is destroyed. It does not precipitate silver from its nitrate, as chlorine does. With water it forms a liquor which corrodes glass and attacks silicon at ordinary temperatures. It is fluorine occluded in the mineral.

In reply to a suggestion that the Germans owe their success to a habit of drudgery acquired in school, the late R. H. Quick, author of Educational Reformers, writes to The Spectator that "without desire—or *interest*—the higher powers of the mind can not come into play; and the habit of painstaking will never be acquired by any amount of 'slaving' away against the grain. Drudgery that is self-imposed, or accepted from a sense of duty, or the desire of some foreseen results, is one thing; to be kept slaving away by your schoolmaster is quite another." He combats a statement of The Spectator that "you can habituate yourself to work ten hours a day as easily as eight," and says, "I have known the experiment of ten hours a day tried, and a very inferior quality of work has been the result."

Some curious instances of individuality—in density of population, wealth, mobility, birth, marriage, and death-rate—have been discovered by M. Dumont in the small towns of France. With one exception, the eleven rural communes in the outskirts of Caen are being depopulated. Great mobility in the rural population is generally associated with a low birth-rate, great fixity with a high one. Side by side in the same department, and even in the same canton, are very different birth-rates. In one canton the birth-rate was steadily low for many years, and then a remarkable rise took place. Equally curious wants of relation are betrayed between the marriage-rates and fecundity.

According to an official report, 1,009 fathers of families in the province of Quebec applied last year for a bounty of 100 acres of crown land which had been offered for every family of twelve living children, and 12,447 children were represented in the applications. The new land-owners are to be collected in groups, which may form parishes later on.

It is intended by the committee of the Royal Society on that enterprise to give the contemplated memorial of the late James Prescott Joule an international character, and to make it contributory to the encouragement of research in physical science. A portion of the money obtained will be applied to a medallion portrait, and the rest directly to this purpose, to be used in the manner that may appear to the council of the society most suitable.

A commission has been appointed by the French Society of Physiological Psychology to investigate the phenomenon in which one imagines he sees or hears an absent person.

In a paper on Shakespeare's References to Natural Phenomena, Miss E. Phipson, after noticing that the play of Richard III was especially rich in such allusions, pointed out that while most poets only found Nature useful for purposes of comparison, Shakespeare was fond of tracing a sympathy between Nature and the works of man. While Shakespeare was the richest in this sort of reference, Drayton came nearest to him, and Chapman followed close. Peele and Greene were essentially artificial in their allusions, and Marlowe almost entirely classical. Shakespeare seemed to love the sun, which to him represented the spirit of good in the world, and to hate the night.

The Rev. George Brown, Superintendent of Australasian Wesleyan Missions, describes the following curious ceremony which he experienced at Guisopa, on one of the islands of New Guinea: "I was standing among the crowd, when one of the principal men came quietly behind me, and, before I knew what he was up to, he blew a mouthful of chewed betel-nut, masooi bark, and spittle over me, which fell in fine spray over my head, neck, and shoulders. The governor and his party, as I found out afterward, had been treated in the same manner prior to my arrival. I suspected the reason for this proceeding, and so did not say anything to the man. It is done, I think, to guard against any evil spirits who might be accompanying us, and as a sign of amity, and that we were free to remain."

Certain low castes of the Vaishnava sect in the Kistna district, southern India, bury their dead, according to Mr. A. Rea, in kistvaens, as follows: "The body is laid horizontally in a shallow grave, the earth is heaped over it in a long, narrow mound, and these kistvaens are then placed over it. They do not approach a square as in the ancient examples, but bear a proportion to the size of the body. At the head and feet are small upright slabs about two feet broad; long slabs are placed upright at the sides, and another of sufficient length and breadth to cover these four upright stones is laid on the top. In some instances a separate stone is placed upright at the head of the grave."

Mr. J. R. Werner has, in his account of his visit to Stanley's rear guard, some pointed remarks on the healthfulness of Nature as compared with the unsanitary conditions induced by civilization. He says: "Nature, when left alone, does her own scavengering; but as civilization advances, the works of man often interfere with the natural drainage, without providing any substitute; and it is only when the population has been decimated by disease that men's eyes are opened. . . . The primitive savage living in his hut has no need of dust-bin or dust-cart. The ants from the large hill close by will soon make short work of any meat he may have left on the bones; the sexton-beetle will soon bury what remains out of sight; and the wind and rain sweep all feathers and dirt into the river. . . . As civilization advances, roads are made, the ant-hills get destroyed, and hawks and carrion birds disappear before the death-dealing shotgun. The natives congregate together in large towns, without any improvement in their sanitary arrangements, where the salutary effects of wind and rain are probably neutralized by the way in which the streets are built; and so things go on till disease is generated and men fall by hundreds."

A reward was offered by the French Government in 1882 for killing wolves. In the next year 1,316 wolves were destroyed; but the number has since decreased almost yearly as follows: 1,035 in 1884, 900 in 1885, 760 in 1886, 701 in 1887, 505 in 1888, and 515 in 1889. It is believed that very soon no specimens of the animal will be left in France except those which occasionally reach it from neighboring countries.

OBITUARY NOTES.

Prof. Julius E. Hilgard, late Superintendent of the United States Coast Survey, died at his home in Washington, May 8th, in his sixty-seventh year. He was born in Bavaria, the son of a jurist of much literary cultivation, and when nine years old came with his father to St. Clair County, Illinois. Here the father settled on a farm and introduced the cultivation of the vine, in connection with which he discovered and made known the merits of the native Catawba grape. Young Hilgard began the study of engineering in Philadelphia in 1843, and two years later entered the service of the United States Coast Survey, in connection with which most of the work of his life was done, and of which he was one of the most valuable and efficient members. In 1881 he became Superintendent of the Coast Survey and so remained till 1885, when he fell a victim to political operations. He was ill at the time, with disorders from which he never recovered. A brief sketch of his life, and a portrait, were published in The Popular Science Monthly for September, 1875.

Colonel Émile Gautier, who, besides his military career, was distinguished in astronomy, died in Geneva, February 25th, of heart disease. He was born in 1822; was directed to astronomical study by his uncle, Alfred Gautier, of the observatory; was a pupil of Leverrier's, and assisted him in his calculations of the perturbations of Uranus; published an essay on the theory of the perturbations of the comets; determined the elements of the planet Metis; observed the solar eclipse of 1860 at Tarragona, Spain, and published his observations; recognized the true nature of the solar prominences, and defended his opinions; became director of the observatory at Geneva on the death of Plantamour, and added many new instruments to the apparatus of the establishment.

Prof. Joseph Leidy, of the University of Pennsylvania, and President of the Philadelphia Academy of Natural Sciences, died April 30th, in the sixty-eighth year of his age. He was distinguished in different fields of science, but most eminently in biology, in which he published more than eight hundred papers. He was a member of the principal American and numerous foreign scientific societies. A sketch of his life and work, by Edward J. Nolan, was published in The Popular Science Monthly for September, 1880.

John Le Conte, Professor of Physics in the University of California, died in Berkely, Cal., April 29th, aged seventy-two years. We have recently given, in The Popular Science Monthly for November, 1889, a full sketch of his life and labors, by his relative and co-worker in physical investigations, Prof. W. Le Conte Stevens, with a full list of his publications.

The death has been announced, in the latter part of March, of M. Auguste Thomas Cahours, a distinguished French chemist, in the seventy-eighth year of his age. He was successively connected with the chemical departments of the Central and Polytechnic Schools in Paris, and was afterward assayer at the Mint. He was one of the earliest to promulgate the later chemical theories. He was the author of works on the density of vapors, the determination of the indexes of refraction of liquids, metallic radicles, sulphurets, etc., and of Elementary Lessons in Chemistry, a text-book highly esteemed in France.

F. W. A. ARGELANDER.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIII. FROM FETICH TO HYGIENE.

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PART I.

ONE of the most striking features in recorded history down to a recent period has been the recurrence of great pestilences. Various indications in ancient times show their frequency, and the famous description of the plague of Athens given by Thucydides, with the discussion of it by Lucretius, show their severity. In the middle ages they raged from time to time throughout Europe; such plagues as the black death and the sweating sickness swept off vast multitudes, the best authorities estimating that of the former, at the middle of the fourteenth century, more than half the population of England died, and that twenty-five millions of people perished in various parts of Europe. In 1552 sixty-seven thousand patients died of the plague in the Hôtel-Dieu at Paris alone, and in 1580 more than twenty thousand. The great plague in England and other parts of Europe in the seventeenth century was also fearful; and that which swept the south of Europe in the early part of the eighteenth century, as well as the invasion of the cholera at various times during the nineteenth, while less terrible than their predecessors, have still left a deep impress upon the imaginations of men.

From the earliest records we find that such pestilences were attributed to the wrath or malice of unseen powers. This had been the view of the heathen even in the most cultured ages before the establishment of Christianity; in Greece and Rome especially, plagues of various sorts were attributed to the wrath of the gods; in Judea, the Scriptural records of various plagues sent upon the earth by the divine fiat as a punishment for sin show the continuance of this mode of thought. Among many examples and intimations of this in our sacred literature, we have the epidemic which carried off fourteen thousand seven hundred of the children of Israel, and which was only stayed by the prayers and offerings of Aaron, the high priest; the destruction of seventy thousand men in the pestilence by which King David was punished for the numbering of Israel, and which was only stopped when the wrath of God was averted by burnt-offerings; the plague threatened by the prophet Zechariah, and that delineated in the Apocalypse. From these sources this current of ideas was poured into the early Christian Church, and hence it has been that during nearly twenty centuries since the rise of Christianity, and down to a period within living memory, at the appearance of any pestilence the church authorities, instead of devising sanitary measures, have very generally preached the necessity of immediate atonement for offenses against the Almighty.

This view of the early Church was enriched greatly by a new development of theological thought regarding the powers of Satan and evil angels. For this, the declaration of St. Paul that the gods of antiquity were devils, was cited as sufficient warrant.*

Moreover, comets, falling stars, and earthquakes were thought upon Scriptural authority to be "signs and wonders"—evidences of the divine wrath, heralds of fearful visitations; and this belief acting powerfully upon the minds of millions of men, did much to create a panic-terror sure to increase the disease wherever it broke forth.

The main cause of this immense sacrifice of life is now known to have been the want of hygienic precautions, both in the Eastern centers where various plagues were developed, and in the European towns through which they spread. And here certain theological reasonings came in to resist the evolution of a proper sanitary theory. Out of the Orient had been poured into the thinking of western Europe the theological idea that the abasement of man adds to the glory of God; that indignity to the body may secure

* For plague during the Peloponnesian wars, see Thucydides, ii, 47–55, and iii, 87. For a general statement regarding this and other plagues in ancient times, see Lucretius, vi, 1090 *et seq.*; and for a translation, see vol. i, p. 325, in Munro's edition of 1864. For early views of sanitary science in Greece and Rome, see Forster's Inquiry in the Pamphleteer, xxiv, 404. For the Greek view of the interference of the gods in disease, especially in pestilence, see Grote's History of Greece, vol. i, pp. 251 and 485, and vol. vi, p. 213; see also Herodotus, lib. iii, xxxiv, and elsewhere. For the Hebrew view of the same interference by the Almighty, see especially Numbers, xi, 4–34; also xvi, 49; 1 Samuel, xxiv; also Psalm cvi, 29; also the well-known texts in Zechariah and Revelations. For St. Paul's declaration that the gods of the heathen were devils, see 1 Cor., x, 20. As to the earlier origin of the plague in Egypt, see Haeser, Lehrbuch der Geschichte der Medicin und der epidemischen Krankheiten, Jena, 1875–'82, vol. iii, pp. 15 *et seq.*

salvation to the soul; hence that cleanliness betokens pride, and filthiness humility. Living in filth was regarded by great numbers of holy men, who set an example to the Church and society, as an evidence of sanctity. St. Jerome and the Breviary of the Roman Church dwell with unction on the fact that St. Hilarion lived his whole life long in utter physical uncleanness; St. Athanasius glorifies St. Anthony because he had never washed his feet; St. Abraham's most striking evidence of holiness was that for fifty years he washed neither his hands nor his feet; St. Sylvia never washed any part of her body save her fingers; St. Euphraxia belonged to a convent in which the nuns religiously abstained from bathing; St. Mary, of Egypt, was eminent for filthiness; St. Simon Stylites was in this respect unspeakable—the only thing that can be said is, that he lived in ordure and stench intolerable to his visitors. The Lives of the Saints dwell with complacency on the statement that when sundry Eastern monks showed a disposition to wash themselves, the Almighty manifested his displeasure by drying up a neighboring stream until the bath which it had supplied was destroyed.

The religious world was far indeed from the inspired utterance attributed to John Wesley, that "cleanliness is near akin to godliness." For century after century the idea prevailed that filthiness was akin to holiness, and while we may well believe that the devotion of the clergy to the sick was a main cause why, during the greater plagues, they lost so large a proportion of their numbers, we can not escape the conclusion that their want of cleanliness had much to do with it; in France, during the fourteenth century, Guy de Chauliac, the great physician of his time, noted particularly that certain Carmelite monks suffered especially from pestilence, and that they were especially filthy; during the black death no less than nine hundred Carthusian monks fell victims in one group of buildings.

Naturally, such an example set by the venerated leaders of thought exercised great influence throughout society, and all the more because it justified the carelessness and sloth to which ordinary humanity is prone. In the principal towns of Europe, as well as in the country at large, down to a recent period, the most ordinary sanitary precautions were neglected, and pestilences continued to be attributed to the wrath of God or the malice of Satan. As to the wrath of God, a new and powerful impulse was given to this belief in the Church toward the end of the sixth century by St. Gregory the Great. In 590, when he was elected Pope, the city of Rome was suffering from a dreadful pestilence: the people died by thousands; out of one procession imploring the mercy of Heaven, no less than eighty persons died within an hour; what the heathen in an earlier epoch had attributed to

Apollo, was now attributed to Jehovah, and chroniclers tell us that fiery darts were seen flung from heaven into the devoted city; but finally, in the midst of all this horror, Gregory, at the head of a penitential procession, saw hovering over the mausoleum of Hadrian the figure of the archangel Michael, who was just sheathing a flaming sword, while three angels were heard chanting the "Regina Cœli." The legend continues that the Pope immediately broke forth into hallelujahs for this sign that the plague was stayed; and as it shortly afterward became less severe, a chapel was built at the summit of the mausoleum and dedicated to St. Michael; still later, above the whole was erected the colossal statue of the archangel sheathing his sword, which still stands to perpetuate the legend. Thus the greatest of Rome's ancient funeral monuments was made to bear testimony to this mediæval belief; the mausoleum of Hadrian became the castle of St. Angelo. A legend like this, claiming to date from the greatest of the early popes, and vouched for by such an imposing monument, had undoubtedly a vast effect upon the dominant theology throughout Europe, which was constantly developing a great body of thought regarding the agencies by which the divine wrath might be averted.

First among these agencies naturally were evidences of devotion, especially gifts of land, money, or privileges to churches, monasteries, and shrines—the seats of fetiches which it was supposed had wrought cures or might work them. The whole evolution of modern history, not only ecclesiastical but civil, has been largely affected by the wealth transferred to the clergy at such periods. It was noted that after the great plague in the fourteenth century, the black death, had passed, an immensely increased proportion of the landed and personal property of every European country was in the hands of the Church; well did a great ecclesiastic remark that "pestilences are the harvests of the ministers of God." *

Other modes of propitiating the higher powers were penitential processions, the parading of images of the Virgin or of saints

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* For triumphant mention of St. Hilarion's filth, see the Roman Breviary for October 21st; and for details, see S. Hieronymus, Vita S. Hilarionis Eremitæ, Migne Patrologia, tome 23. For the filthiness of the other saints named, see citations from Lives of the Saints in Lecky's History of European Morals, vol. ii, pp. 117, 118. For Guy de Chauliac's observation on the filthiness of Carmelite monks and their great losses by pestilence, see Meryon, History of Medicine, vol. i, p. 257. For the mortality among the Carthusian monks in time of plague, see Mrs. Lecky's very interesting Visit to the Grand Chartreuse, in The Nineteenth Century for March, 1891. For the plague at Rome in 590, the legend regarding the fiery darts, mentioned by Gregory of Tours, and that of the castle of St. Angelo, see Gregorovius, Geschichte der Stadt Rom im Mittelalter, vol. ii, pp. 26, 35. Also, Story, Castle of St. Angelo, etc., chap. ii. For the remark that "pestilences are the harvest of the ministers of God," see Charlevoix, given in Southey, History of Brazil, vol. ii, p. 254, cited in Buckle, vol. i, p. 130, note.

through plague-stricken towns, and innumerable fetiches. Very noted in the thirteenth and fourteenth centuries were the processions of the flagellants, trooping through various parts of Europe, scourging their naked bodies, and shrieking the penitential psalms, often running from wild excesses of devotion to the maddest orgies.

Sometimes, too, plagues were attributed to the wrath of lesser heavenly powers: just as, in former times, the fury of far-darting Apollo was felt when his name was not respectfully treated by mortals, so in 1680 the church authorities at Rome discovered that the plague then raging resulted from the anger of St. Sebastian, because no monument had been erected to him; such a monument was therefore placed in the church of St. Peter ad Vincula, and the plague ceased.

So much for the endeavor to avert the wrath of the heavenly powers. On the other hand, theological reasoning no less subtle was used in thwarting the malice of Satan. This idea, too, came from far. In the sacred books of India and Persia, as well as in our own, we find the same theory of disease, leading to similar means of cure. Perhaps the most astounding among Christian survivals of this theory and its resultant practices was seen during the plague at Rome in 1522. In that year, at that center of divine illumination, certain people, having reasoned upon the matter, came to the conclusion that this great scourge was the result of satanic malice; and in view of St. Paul's declaration that the ancient gods were devils, and of the theory that the ancient gods of Rome were the devils who had the most reason to punish that city for their dethronement, and that the great amphitheatre was the chosen haunt of these demon gods, an ox decorated with garlands, after the ancient heathen manner, was taken in procession to the Colosseum and solemnly sacrificed. Even this proved vain, and the church authorities then ordered expiatory processions and ceremonies to propitate the Almighty, the Virgin, and the saints, who had been offended by this temporary effort to bribe their enemies.

But this sort of theological reasoning developed an idea far more disastrous, and this was that Satan, in causing pestilences, used as his emissaries especially Jews and witches. The proof of this belief in the case of the Jews was seen in the fact that they escaped with a less percentage of disease than did the Christians in the great plague periods. This was doubtless due in some measure to their remarkable sanitary system, which had probably originated thousands of years before in Egypt, and had been handed down through Jewish lawgivers and statesmen. Certainly they observed more careful sanitary rules and more constant abstinence from dangerous foods than was usual among Christians; but the public at large could not understand so simple a cause, and jumped to the conclusion that their immunity resulted from protection by Satan, and that this favor was repaid and the pestilence caused by their wholesale poisoning of Christians. As a result of this mode of thought, attempts were made in all parts of Europe to propitiate the Almighty, to thwart Satan, and stop the plague by torture and murder of the Jews. Throughout Europe during great pestilences we hear of extensive burnings of this devoted people. In Bavaria, at the time of the "black death," it is computed that twelve thousand Jews thus perished; in the small town of Erfurt, the number is said to have been three thousand; in Strasburg the Rue Brulée remains as a monument to the two thousand Jews burned in it for poisoning the wells and causing the plague of 1348; at the royal castle of Chinon, near Tours, an immense trench was dug, filled with blazing wood, and in a single day one hundred and sixty Jews were burned. Everywhere in continental Europe this mad persecution went on; but it is a pleasure to say that one man, Pope Clement VI, stood against this mass of popular unreason, and, so far as he could bring his influence to bear on the maddened populace, it was exercised in favor of mercy to these supposed enemies of the Almighty.*

As to witches, the reasons for believing them the cause of pestilence also came from far. This belief, too, had been poured into the early Church from Oriental sources, and was strengthened by a whole line of church authorities, fathers, doctors, and saints; but, above all, by the great bull, "Summis Desiderantes," issued by Pope Innocent VIII, in 1484. This utterance from the seat of St. Peter infallibly committed the Church to the idea that witches are a great cause of disease, storms, and various ills which

* For an early conception in India of the Divinity acting through medicine, see The Bhagavadgîtâ, translated by Telang, p. 82, in Max Müller's Sacred Books of the East. For the necessity of religious means of securing knowledge of medicine, see the Anagîtâ, translated by Telang, in Max Müller's Sacred Books of the East, p. 388. For ancient Persian ideas of sickness as sent by the spirit of evil and to be cured by spells, but not excluding medicine and surgery, and for sickness generally as caused by the evil principle in demons, see the Zend-Avesta, Darmesteter's translation, in Max Müller's Sacred Books of the East, introduction *passim*, but especially xciii. For diseases wrought by witchcraft, see Zend-Avesta, Darmesteter's translation, pp. 230 and 293. On the preference of spells in healing over medicine and surgery, see Zend-Avesta, vol. i, pp. 85, 86. For healing by magic in ancient Greece see, e. g., the cure of Ulysses in the Odyssey, "They stopped the black blood by a spell" (Odyssey, xix, 457). For medicine in Egypt as partly priestly and partly in the hands of physicians, see Rawlinson's Herodotus, vol. ii, p. 136, note. For ideas of curing of diseases by expulsion of demons still surviving among various tribes and nations of Asia, see J. G. Frazer, The Golden Bough, a Study of Comparative Religion, London, 1890, pp. 184–192. For the flagellants and their processions at the time of the black death, see Lea, History of the Inquisition, New York, 1888, vol. ii, p. 381 *et seq.* For the persecution of the Jews in time of pestilence, see ibid., p. 379 and following, with authorities in the notes.

afflict humanity, and the Scripture on which the action recommended against witches in this papal bull, as well as in so many sermons and treatises for centuries afterward, was based, was the famous text, "Thou shalt not suffer a witch to live." This idea persisted long; and the evolution of it is among the most fearful things in human history.*

In Germany this development was especially terrible. From the middle of the sixteenth century to the middle of the seventeenth, Catholic and Protestant theologians and ecclesiastics vied with each other in detecting witches guilty of producing sickness or bad weather; women were sent to torture and death by thousands, and with them, from time to time, men and children. On the Catholic side sufficient warrant for this work was found in the bull of Pope Innocent VIII, and the bishops' palaces of south Germany became shambles—the lordly prelates of Salzburg, Würzburg, and Bamberg taking the lead in this butchery.

In north Germany Protestantism was just as conscientiously cruel. It based its theory and practice toward witches directly upon the Bible, and above all on the great text which has cost the lives of so many myriads of innocent men, women, and children: "Thou shalt not suffer a witch to live." Naturally the Protestant authorities strove to show that Protestantism was

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* On the plagues generally, see Hecker, Epidemics of the Middle Ages, *passim;* but especially Haeser, as above III. Band, s., pp. 1–202; also, Sprengel, Baas, Isensee, *et al.* For brief statement showing the enormous loss of life in these plagues, see Littré, Médecine et Médecins, Paris, 1875, p. 3 *et seq.* For a summary of the effects of the Black Plague throughout England, see Green's History of the English People, chap. v. For the mortality in the Paris hospitals, see Desmazes, Supplices, Prisons et Graces en France, Paris, 1866. For striking descriptions of plague-stricken cities, see the well-known passages in Thucydides, Bocaccio, De Foe, and above all, Manzoni's Promessi Sposi. For examples of averting the plagues by processions, see Leopold Delisle, Études sur la Condition de la Classe Agricole, etc., en Normandie au Moyen Age, p. 630; also Fort, chap. xxiii. For the anger of St. Sebastian as a cause of the Plague at Rome, and its cessation when a monument had been erected to him, see Paulus Diaconus, cited in Gregorovius, vol. ii, p. 165. For the sacrifice of an ox in the Colosseum to the ancient gods as a means of averting the plague of 1522, at Rome, see Gregorovius, vol. viii, p. 390. As to massacres of the Jews in order to averting the wrath of God in pestilence, see L'École et la Science, Paris, 1887, p. 178; also Hecker, and especially Hoeniger, Gang und Verbreitung des Schwarzen Todes in Deutschland, Berlin, 1880. As to absolute want of sanitary precautions, see Hecker, p. 292. As to condemnation by strong religionists of medical means in the plague, see Fort, p. 130. For a detailed account of the action of Popes Eugene IV and Innocent VIII against witchcraft, ascribing to it storms and diseases, and for the bull "Summis Desiderantes," see the chapter on Meteorology in this series. The text of the bull is given in the Malleus Maleficarum, in Binsfeld, and in Roskoff, Geschichte des Teufels, Leipzig, 1869, vol. i, pp. 222–225, and a good summary and analysis of it in Soldan, Geschichte der Hexenprocesse. For a concise and admirable statement of the contents and effects of the bull, see Lea, History of the Inquisition, vol. iii, pp. 40 *et seq.;* and for the best statement known to me of the general subject, Prof. George L. Burr's paper on witchcraft, read before the American Historical Association at Washington.

no less orthodox in this respect than Catholicism, and such theological jurists as Carpzov, Damhouder, and Calov did their work thoroughly; the most moderate of authorities on this subject places the number of victims thus sacrificed during that century in Germany alone at over a hundred thousand.

Among the methods of this witch activity especially credited in central and southern Europe was the anointing of city walls and pavements with a diabolical unguent causing pestilence. In 1530 Michael Caddo was executed with fearful tortures for thus besmearing the pavements of Geneva; but far more dreadful was the torturing to death of a large body of people at Milan, a hundred years later, for producing the plague by anointing the city walls. This case in Milan may be briefly summarized as showing the ideas of all classes from highest to lowest on sanitary science in the seventeenth century. That city was then under the control of Spain, and its authorities having received from the Spanish Government notice that certain persons suspected of witchcraft had recently left Madrid, and had perhaps gone to Milan to anoint the walls, this communication was dwelt upon in the pulpits as another evidence of that satanic malice which the Church alone had the means of resisting, and the people were thus excited and put upon the alert. One morning, in the year 1630, an old woman, looking out of her window, saw a man walking along the street and wiping his fingers upon the walls; she immediately called the attention of another old woman, and they agreed that this man must be one of the diabolical anointers. It was perfectly evident to a person under ordinary conditions that this unfortunate man was simply trying to remove from his fingers the ink gathered while writing from the ink-horn which he carried in his girdle; but this explanation was too simple to satisfy those who first observed him or those who afterward tried him: a mob was raised and he was thrown into prison. Being tortured, he at first did not know what to confess; but, on inquiring from the jailer and others, he learned what the charge was, and on being again submitted to torture utterly beyond endurance, he confessed everything which was suggested to him; and on being tortured again and again to give the names of his accomplices, he accused, at hazard, the first people in the city whom he thought of. These, being arrested and tortured beyond endurance, confessed and implicated a still greater number, until members of the foremost families were included in the charge. Again and again all these unfortunates were tortured beyond endurance. Under paganism the rule regarding torture had been that it should not be carried beyond human endurance; and we therefore find Cicero ridiculing it as a means of detecting crime, because a stalwart criminal of strong nerves might resist it and go free, while a physically delicate man, though innocent, would be forced to confess. Hence it was that under paganism a limit was imposed to the torture which could be administered; but when Christianity had become predominant throughout Europe, torture was developed with a cruelty never before known. The theological doctrine of "excepted cases" was evolved—these "excepted cases" being heresy and witchcraft; for by a very simple and natural process of theological reasoning it was held that Satan would give supernatural strength to his special devotees—that is, to heretics and witches; and therefore, that in dealing with them there should be no limits to the torture. The result was in this particular case, as in tens of thousands besides, that the accused confessed everything which could be suggested to them, and often in the delirium of their agony confessed far more than all that the zeal of the prosecutors could suggest. Finally, a great number of worthy people were sentenced to the most cruel death which could be invented. The records of their trials and deaths are frightful. The treatise which in recent years has first brought to light in connected form an authentic account of the proceedings in this affair, and which gives at the end engravings of the accused submitting to horrible tortures on their way to the stake and at the place of execution itself, is one of the most fearful monuments of theological reasoning and human folly.

To cap the climax, after a poor apothecary had been tortured into a confession that he had made the magic ointment, and had been put to death with the most exquisite refinements of torture, his family were obliged to take another name, and were driven out from the city; his house was torn down, and on its site was erected "The Column of Infamy," which remained on this spot until, toward the end of the eighteenth century, a party of young radicals, probably influenced by the reading of Beccaria, sallied forth one night and leveled this pious monument to the ground.

Herein was seen the culmination and decline of the bull "Summis Desiderantes." It had been issued by him whom a vast majority of the Christian world believes to be infallible in his teachings to the Church as regards faith and morals; yet here was a deliberate utterance in a matter of faith and morals which even children now know to be utterly untrue. Though Beccaria's book on Crimes and Punishments, with its declarations against torture, was placed by the church authorities upon the Index, and though the faithful throughout the Christian world were forbidden to read it, even this could not prevent the victory of truth over this infallible utterance of Innocent VIII.*

* As to the fearful effects of the papal bull "Summis Desiderantes" in south Germany, on the Protestant severities in north Germany, and the immense number of women

As the seventeenth century went on, the whole ingenuity of the human mind in all parts of Europe seemed devoted to new developments of fetichism. A very curious monument of their further evolution in Italy is seen in the Royal Gallery of Paintings at Naples: upon the walls hang several pictures representing the measures taken to save the city from the plague during the seventeenth century, but especially from the plague of 1656. One enormous canvas gives a curious example of the theological doctrine of intercession between man and his Maker, spun out to its logical length: in the background is the plague-stricken city; in the foreground the people are praying to the city authorities to avert the plague; the city authorities are praying to the Carthusian monks; the monks are praying to St. Martin, St. Bruno, and St. Januarius; these three saints in their turn are praying to the Virgin; the Virgin prays to Christ, and Christ prays to the Almighty. Still another picture represents the people led by the priests executing with horrible tortures the Jews, heretics, and witches who were supposed to cause the pestilence of 1656, while in the heavens the Virgin and St. Januarius are interceding with Christ to sheathe his sword and stop the plague.

In such an atmosphere of thought it is no wonder that the death statistics are appalling. We hear of districts in which not more than one in ten escaped, and some were entirely depopulated. Such appeals to fetich against pestilence have continued in Naples down to our own time, the great saving power being the liquefaction of the blood of St. Januarius. In 1856 the present writer saw this miracle performed in the gorgeous chapel of the saint, forming part of the Cathedral of Naples. The chapel was filled with devout worshipers of every class, from the officials in court dress, representing the Bourbon king, down to the lowest lazzaroni. The reliquary of silver-gilt, shaped like a large human head, and supposed to contain the skull of the saint, was first placed upon the altar; next, two vials containing a dark substance said to be his blood, having been taken from the wall, were also placed upon the altar near the head. As the priests said masses and repeated the creeds, they turned the vials from time

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and children put to death for witchcraft in Germany generally, for spreading storms and pestilence, and for the monstrous doctrine of "excepted cases," see the standard authorities on witchcraft, especially Wächter, Beiträge zur Geschichte des Strafrechts, Soldan, Horst, Hauber, and others; also Burr, as above. In another series of Chapters on the Warfare of Humanity, I intend to go more fully into the subject. For the magic spreading of the plague at Milan, see Manzoni, I Promessi Sposi, and Colonna Infame; and for the origin of the charges with all the details of the trial, see the Processo Originale degli Untori, Milan, 1839, *passim*, but especially the large folding plate at the end, exhibiting the tortures. For the after-history of the Column of Infamy, and for the placing of Beccaria's book on the Index, see Cantu, Vita di Beccaria. For the magic spreading of the plague in general, see Littré, pp. 492 and following.

to time, and the liquefaction being somewhat delayed, the great mass of people burst out into expostulations and petitions to the saint, more and more impassioned. Just in front of the altar were the lazzaroni who claimed to be descendants of the saint's family, and these were especially importunate: at such times they beg, they scold, they even threaten; they have been known to abuse the saint roundly, and to tell him that, if he did not care to show his favor to the city by liquefying his blood, St. Cosmo and St. Damian were just as good saints as he, and would no doubt be very glad to have the city devote itself to them. At last, on the occasion of my visit, the priest, turning the vials suddenly, announced that the saint had performed the miracle, and instantly priests, people, choir, and organ burst forth into a great *Te Deum*, bells rang, and cannon roared; a procession was formed, and the shrine containing the saint's relics was carried through the streets, the people prostrating themselves on both sides of the way and throwing showers of rose leaves upon the shrine and upon the path before it. The contents of these precious vials are an interesting relic indeed, for they represent to us vividly that period when men who were willing to go to the stake for their religious opinions thought it not wrong to save the souls of their fellow-men by pious mendacity and sanctified fraud. To the scientific eye this miracle is very simple: the vials contain, no doubt, one of those mixtures fusing at low temperature which, while kept in its place within the cold stone walls of the church, remains solid, but upon being brought out into the hot, crowded chapel, and fondled by the warm hands of the priests, gradually softens and becomes liquid. It was curious to note, at the time above mentioned, that even the high functionaries representing the king looked at the miracle with awe; they evidently found "joy in believing," and one of them assured the writer that the only thing which *could* cause it was the direct exercise of miraculous power.

It may be reassuring to persons contemplating a visit to that beautiful capital in these days, that, while this miracle still goes on, it is no longer the only thing relied upon to preserve the public health. An unbelieving generation, especially taught by the recent horrors of the cholera, has thought it wise to supplement this power by the "Risanamento," begun mainly in 1885 and still going on. The drainage of the city has thus been greatly improved, the old wells closed, and pure water introduced from the mountains. Moreover, at the last outburst of cholera a few years since, a noble deed was done which, by its moral effect, exercised a widespread healing power. Upon hearing of this terrific outbreak of pestilence, King Humbert, though under the ban of the Church, broke from all the entreaties of his friends and family, went directly into the plague-stricken city, and there, in the streets, public places, and hospitals, encouraged the living, comforted the sick and dying, and took means to prevent a further spread of the pestilence. To the credit of the Church it should also be said that the Cardinal Archbishop San Felice joined him in this.

Miracle for miracle, the effect of this visit of the king seems to have surpassed anything that St. Januarius could do, for it gave confidence and courage which very soon showed their effects in diminishing the number of deaths. It would certainly appear that in this matter the king was more directly under divine inspiration and guidance than was the Pope, for the fact that King Humbert went to Naples at the risk of his life, while Leo XIII remained in safety at the Vatican, impressed the Italian people in favor of the new *régime* and against the old as nothing else could have done.

In other parts of Italy the same progress is seen under the new Italian Government. Venice, Genoa, Leghorn, and especially Rome which under the sway of the popes was always scandalously filthy, are now among the cleanest cities in Europe. What the relics of St. Januarius, St. Anthony, and a multitude of local fetiches throughout Italy were for ages utterly unable to do, has been accomplished by the development of the simplest sanitary principles.

Spain shows much the same characteristics of a country where theological considerations have been all-controlling for centuries. Down to the interference of Napoleon with that kingdom, all sanitary efforts were looked upon as absurd if not impious. The most sober accounts of travelers in the Spanish Peninsula until a recent period are sometimes irresistibly comic in their pictures of peoples insisting on maintaining arrangements more filthy than any which would be permitted in an American backwoods camp, while taking enormous pains to stop the pestilence by bell-ringings, processions, and new dresses bestowed upon the local Madonna; yet here, too, a healthful skepticism has begun to work for good: the outbreaks of cholera in recent years have done some little to bring in better sanitary measures.*

* As to recourse to fetichism in Italy in time of plague, and the pictures showing the intercession of Januarius and other saints, I have relied on my own notes made at various visits to Naples. For the general subject, see Peter Études, Napolitaines, especially chapters v and vi. For detailed accounts of the liquefaction of St. Januarius's blood by eye-witnesses, one an eminent Catholic of the seventeenth century, and the other a distinguished Protestant of our own time, see Murray's Handbook for South Italy and Naples, description of the Cathedral of San Gennaro. For the incredible filthiness of the great cities of Spain, and the resistance of the people, down to a recent period, to the most ordinary regulations prompted by decency, see Bascome, History of Epidemic Pestilences, especially pp. 119, 120. See also Autobiography of D'Ewes, London, 1845, vol. ii, p. 446; also, for various citations, the second volume of Buckle, History of Civilization in England.

THE VALUE OF STATISTICS.

By Hon. CARROLL D. WRIGHT.

THE German historian Schlosser has said that history is statistics ever advancing, and statistics is stationary history. Looking beneath the words of Schlosser, one must conclude that he means that the constant accumulation of statistical data from period to period, or from epoch to epoch—that is, statistics ever in motion—creates history, history being made up of the ever-advancing events of life, which are shown through statistical methods, but that statistics of one epoch constitutes the permanent history thereof. The statistician, therefore, in the truest sense, writes history, and he writes it in the most crystallized form which can be adopted. He uses symbols, it is true, but with them he unlocks the facts of his period, so that they may be made plain to all students coming after him; he tells the story of our present state, that when the age we live in becomes the past, that story shall be found to exist in true and just proportions. The very word "statistics" indicates the soundness of the German writer's thought. The word is from the French *statistique*—from the Greek *statos*, meaning fixed, settled; *statos* being based on the stem *sta*, meaning to stand. Statistics, then, is used to illustrate fixed and settled conditions.

As a department of political science, statistics is used to classify, arrange, and discuss facts relating to a part or the whole of a country or people, or facts relating to classes of individuals or interests in different countries, and especially those facts which illustrate the physical, social, moral, intellectual, political, industrial, and economical condition or changes of condition of the people, in so far as such conditions may be indicated through numerical and tabular statements.

It is not a matter of much consequence whether statistics is a science or a method. English writers on statistics generally consider that it constitutes a method. Continental writers more generally insist upon its being denominated a science. The American opinion follows that of the Continent. It is true that statistical research can be called a scientific method of determining facts, and for studying various phenomena from which laws relating to life, production, distribution, consumption, etc., can be drawn; and the method must be considered scientific, because by it facts can be clearly stated, classified, and analyzed, elements which make science. We speak of the science of botany, because, for one reason, all the facts relating to botany can be classified; and so as to other departments of knowledge, classification or the lack of it determining the scientific or unscientific character of the knowledge. Science demands a classification of facts so rigid that all men will consent to its integrity and to its use.

Whether statistics is a science or a scientific method, its use is sometimes empirical, deceptive, and illusory, and even dishonest; and because of these things the method is often condemned. We frequently hear it said that nothing is so uncertain as figures, and many writers contend that no thorough dependence can be placed upon statistical data. One long engaged in statistical work feels more and more keenly, as the results of original investigation, not only the limitations of statistics, but the fact that perfectly honest and truthful statistical tables may not only be vicious in themselves, but may also lead to the most worthless conclusions, the tables themselves not indicating, and it not being possible to fully indicate by them, the exact truth they contain. The method, I believe, is the surest for ascertaining conditions, and the truest on which to base conclusions; but the method must be supplemented by full and frank analysis. A statistical table, independent of such analysis, is to me what a red flag is to a bull. It immediately excites antagonism and invites attack. The value of any statistical presentation must depend upon the basis upon which it is made, the integrity of the collection of the various elements of it, and the analysis which accompanies it. No one has any right to quote statistical tables without using and understanding the analysis of them. It is because of the flippant and careless use of statistics by writers and speakers that it receives their condemnation. No one thinks, however, of condemning anæsthetics because the burglar chloroforms his victim; or the elementary rules of arithmetic, the means by which all honest accounts are kept, simply because dishonest accounts are made possible by the same means; yet I know that, because so many instances of the lying use of honest statistics meet one's observation, it is not remarkable that there are so many surprising denunciations of the method, and that we hear the oft-repeated statement that anything can be proved by statistics—a statement usually made for the purpose of belittling the importance and value of the method under discussion. It is perfectly true that one so disposed can, by dropping an essential element of a table, show the exact reverse of the truth, or, by a combination of truthful elements, prove an untruth; just as the foolish man thought he could prove by the Bible that there was no God, by quoting the exact language of the Psalms in the statement "There is no God," the whole statement being, "The fool hath said in his heart, There is no God." Such a use of statistics belongs to the theorist, who cares more for his idea than for the truth; who cares more for his view of the conditions of life than for the historical fact. Statistics is as dangerous in the hands of such a person as it is in the hands of the statistical mechanic—the man who is ready at all times to construct tables showing such points as may be ordered of him. This latter person is a nuisance. He perverts facts and shows how to reach conclusions false in themselves by the use of truthful statements. Some practical illustrations drawn from actual experience may be of value, and show how we can guard against vicious conclusions when the statistical statements from which the conclusions are drawn are true. This method will also show the true value of statistics.

I have seen it argued that the production of cheese in the United States is growing smaller and smaller, and is likely to cease entirely. This argument is based upon the following figures, taken from the agricultural statistics of the Federal censuses of 1850, '60, '70, and '80: The production of cheese, according to such statistics, was, in 1850, 105,535,893 pounds; in 1860, 103,663,927 pounds; in 1870, 53,492,153 pounds; and in 1880, 27,272,489 pounds. Nothing could be more conclusive as evidence than these figures, because, while the statement for 1850 might be erroneous on account of imperfect enumeration, the enumerations have grown more and more complete; and if the 1880 figures show only about one quarter of the product of 1850, the cheese industry must soon cease to exist. A very little study and a very small amount of common knowledge would have taught the one using the argument I have quoted to examine the statistics of manufactures, as the production of cheese has been thrown largely into the factory. By consulting this side of the census, it is found that the production of cheese in factories in 1880 was 171,750,495 pounds; the truth being, therefore, that the production of cheese in the United States is, as one would naturally suppose, largely on the increase.

One of the most common statistical illustrations used in political arguments is that relating to the percentage of increase of population as compared with the percentage of increase in expenditures. I have prepared a little table (which I have never seen in print) showing the factors used in such an argument, supplemented by factors which ought to be used. The table is as follows:

Statement showing, decennially, the expenditures of the Government and the population of the United States from 1830 to 1890, inclusive, and the value of manufactured products in the United States from 1850 to 1880, inclusive, with the percentage of increase.

YEAR.	Expenditures.*	Per cent increase.	Per cent increase over 1850.	Population.	Per cent increase.	Per cent increase over 1850.	Value of manufactured products.	Per cent increase.	Per cent increase over 1850.
1830	$11,866,236 02	......	......	12,866,020	......	......	....	......	......
1840	21,536,357 94	81·49	......	17,069,453	33·52	......	....	......	......
1850	35,299,104 07	63·90	......	23,191,876	35·83	......	1,019,106,616	......	......
1860	58,955,952 89	67·01	......	31,443,821	35·11	......	1,885,861,676	65·42	......
1870	136,081,304 98	130·82†	......	38,558,371	22·63	......	4,232,325,442	124·42	......
1880	112,312,887 81	17·47†	218·17	50,155,783	30·08	116·26	5,369,579,191	26·87	426·89
1890	154,700,347 48	41·30	338·26	62,622,250	24·86	170·45	....	......	......

* Expenditures on account of interest, pensions, premiums, and the principal of the public debt are not included.

† The marked increase in expenditures for the year 1870 over 1860 is largely due to the augmentation of the army and navy, caused by the civil war; and the decrease shown for 1880 is accounted for by the reductions made in the military and naval establishments.

Looking at one part of the foregoing table, it will be seen that between 1850 and 1890 the population increased 170·45 per cent, while the expenditures of the Government for the same period increased 338·36 per cent, the percentage of increase in expenditures being enormously in excess of the increase in population. If, however, one should examine the business side, which offers the truer basis of comparison, so far as expenditures are concerned, it will be seen that the percentage of increase in 1880 over 1850 was 426·89 per cent. The figures for 1890 are not yet available. Taking the same year, that is, 1880, for the three elements, we find that the population increased in 1880 as over 1850 116·26 per cent, expenditures for the same period 218·17 per cent, and the value of manufactured products increased 426·89 per cent. To carry this illustration to its logical completeness, the statistics of valuations and some others should be added, but they would simply be accumulative on the business side of the comparison as against the simple comparison of expenditures with population.

Criminal statistics are, perhaps, the most misleading, even when absolutely correct. The attempt is often made to compare the criminal statistics of one State with those of another, in order to determine relative criminal conditions. Such a comparison is and must be thoroughly vicious in every element. One illustration will be sufficient. Suppose one should undertake, as has been the case, to compare the criminal conditions of Massachusetts and Virginia by means of the statistics of crime. Such a comparison would lead only to unjust conclusions, to angry discussion, and to general ill-feeling, for the reason that the criminal codes of the two States differ widely. A few years ago I had occasion to examine this subject, and I found that the criminal code of Massachusetts, at the time the study was made, provided for the punishment of 158 offenses designated as crimes, and the sentences under the statutes of course appeared in the criminal statistics of Massachusetts. The code of Virginia at the same time recognized but 108 such offenses as crimes punishable at law; that is, there were 50 distinct offenses known to the Massachusetts law which were not to be found in the criminal laws of Virginia. No honest comparison, therefore, could be made between the criminal statistics of the two States, and a truthful statement of such statistics in comparison would lead to the most dishonest conclusions. Even with parallel codes and with accurate statistics of the number of persons in prison for crime, no conclusions would be justifiable, for of the offenses common to both States several were punishable by imprisonment in Massachusetts, but by fine only in Virginia. So the prison statistics would show sentences under grave crimes in Massachusetts, while the prison statistics of Virginia would show that no one had been sentenced for such crimes. The grave offenses coming under this distinction are adultery, fornication, lewd conduct, drunkenness, carrying concealed weapons, extortion. From official returns made to the Secretary of the Commonwealth of Massachusetts from the various prisons for the year in which the previous study was made, it appeared that more than 54 per cent of the commitments were for crimes which in Virginia would have been punished by fine only, and the persons so punished never would have appeared, of course, in the prison statistics of the former State. Statistically speaking, then, the only comparisons that would approach fairness, under the conditions named, would be to reduce the actual number of prisoners confined for crimes in Massachusetts 33 per cent to conform to the number of crimes known to the two States in common. The balance, then, would have to be reduced 54 per cent on account of the crimes punishable in Massachusetts by imprisonment for which a fine only is imposed in Virginia. This illustration indicates how unwise it is to undertake to prove the moral or immoral condition of one community as compared with another by criminal statistics. The more accurate the statistics, the more unjust and vicious the comparison.

Another exceedingly effective illustration drawn from criminal statistics relates to some of the most perfect statistical showings I have ever had occasion to examine. From the year 1860 to 1879, inclusive, the criminal statistics of Massachusetts are perfect, and are the results of the certified reports of the clerks of all the criminal courts in the State. From the official statistics, as reported by the Massachusetts Bureau of Statistics of Labor in its Eleventh Annual Report, January, 1880, I have drawn certain comparative columns covering the crime of Massachusetts for the twenty years named. These columns are shown in the table on page 450.

What would a superficial examination of the foregoing figures, which, as I have said, are among the most accurate statistics I have ever examined, prove as to the progress of crime in the State named? I will use what I have seen or have known others to use, referring to these statistics. The increase in population in Massachusetts for the twenty years covered by the table was 50·4 per cent. The percentage of increase of crime for the same period was 70·4 per cent. If we look back to 1875, we shall find that the table shows that the population increased 34·1 per cent over 1860, and that for the same period crime increased 144 per cent, while in 1873 the increase of crime was 179·3 per cent. These figures, perfectly true and accurate, used deftly, give an exceedingly black eye to the State of Massachusetts, and no one can gainsay the bare statistical conclusion or attack the accuracy of the figures on which the conclusion is based. A very casual study of all the

Statement showing sentences in the State of Massachusetts for all classes of offenses, for drunkenness, including common drunkards, for crimes other than drunkenness and liquor offenses, and for high crimes, from 1860 to 1879 inclusive, with the annual per cent of decrease or increase since 1860.

YEAR.	POPULATION.		ALL CLASSES OF OFFENSES.		DRUNKENNESS, INCLUDING COMMON DRUNKARDS.		CRIMES OTHER THAN DRUNKENNESS AND LIQUOR OFFENSES.		HIGH CRIMES.	
	Total.	Per cent increase over 1860.	Total.	Per cent increase or decrease since 1860.	Total.	Per cent increase or decrease since 1860.	Total.	Per cent increase or decrease since 1860.	Total.	Per cent increase or decrease since 1860.
1860	1,231,005	....	16,513	....	6,334	....	9,385	....	331	....
1861	....	....	14,294	13·4 dec.	4,426	30 1 dec.	9,339	5 dec.	382	....
1862	....	....	13,934	15·6 "	6,065	4·2 "	7,465	20·4 "	214	....
1863	....	....	14,859	10 "	7,066	11·5 inc.	7,247	21 7 "	162	....
1864	....	....	15,858	3·9 "	7,526	18·8 "	7,788	17 "	119	....
1865	1,267,030	2·9	17,276	4·6 inc.	8,060	27 2 "	8,507	9·3 "	206	37·8 dec.
1866	....	....	22,489	36·1 "	11,563	82·5 "	9,807	4·4 inc.	312	....
1867	....	....	26,281	59·1 "	11,019	74·1 "	11,588	23·4 "	275	....
1868	....	....	25,857	56·5 "	12,920	103·9 "	10,871	15 3 "	399	....
1869	....	....	31,850	93·1 "	16,742	164·3 "	12,160	29·5 "	317	....
1870	1,457,351	18·3	39,693	140·3 "	18,880	198 "	13,310	41 9 "	394	19 inc.
1871	....	....	39,869	141·4 "	20,383	221·8 "	12,231	30 3 "	283	....
1872	....	....	45,297	174 3 "	23,587	272·3 "	13,498	43·9 "	310	....
1873	....	....	46,132	179·3 "	23,842	276 4 "	14,227	51·5 "	459	....
1874	....	...	43,684	164·5 "	22,748	259·1 "	14,506	54·5 "	455	....
1875	1,651,912	34 1	40,404	144 "	23,553	271·8 "	14,613	55·8 "	500	51 1 inc.
1876	....	....	33,103	100 "	18,107	185·8 "	13,805	47·4 "	490	....
1877	....	...	31,688	91·8 "	17,614	178 "	12,826	36·5 "	525	....
1878	....	....	31,118	88·4 "	16,795	165·1 "	13,340	42·1 "	626	....
1879	1,852,586*	50·4	28,149	70·4 "	16,211	155·9 "	11,278	20·1 "	462	39·6 inc.

* Estimated.

facts, however, relieves the Commonwealth of the oft-repeated statement that crime is increasing much faster than population. The total number of sentences for all offenses for the twenty years is 578,348. An examination of the column of the foregoing table headed "Drunkenness, including common drunkards," shows that the percentage of increase since 1860 is 155·9 per cent, the total tal being 340,814; that is to say, 60 per cent of the total number of crimes reported under all classes of offenses belong entirely to what may be called "rum offenses." An examination of the statistics of crimes other than drunkenness and liquor offenses shows that the increase for the twenty years from 1860 to 1879, inclusive, was but 20·1 per cent, as against an increase of 50·4 per cent in the population. But the truest comparison is based on what are called "high crimes." These are the crimes which represent criminal conditions more than any other. They are the crimes of abortion, felonious assault, burglary, breaking and entering, burning a building, embezzlement, forgery, incest, murder, manslaughter, robbery, and rape. The total number of sentences under all these high crimes for the twenty years is shown in the foregoing table, with percentage of increase since 1860 brought into comparison with the increase of population. This increase in 1879 was 39·6 per cent over 1860, while the population for the same time had increased 50·4 per cent. This side of the table shows that any argument made to prove that the crime of the State of Massachusetts for the twenty years named increased much more rapidly than the population is a vicious argument and the conclusion a false one.

The high crimes are those that have been always recognized as crimes. The crime of drunkenness and other crimes belonging to liquor legislation are modern, and in the light of this statement the table receives valuable explanation. In Massachusetts the prohibitory law of 1855 was in force until 1868, when a license law was passed. Under the former the vigorous prosecutions of 1866 and 1867 caused the number of sentences to increase rapidly, and this led to a repeal of the prohibitory law and the enactment of the license law of 1868. The friends of the license law insisted upon its vigorous enforcement, and this action carried the number of rum convictions of all grades still higher, when another reaction secured the re-enactment of the prohibitory law, which went into effect July 1, 1869, and under the application of this law the lines of figures representing drunkenness and liquor offenses went to their highest point in 1872. In 1870 the Legislature allowed the free sale of "ale, porter, strong beer, and lager beer," everywhere, unless prohibited by a vote of a city or town. This law was repealed in 1873. From the year 1873, either through the effect of the repeal of the beer law or of waning interest in the prohibitory law, resulting in decreased vigilance in prosecutions, the lines of figures dropped till 1875, when the prohibitory law was repealed. From 1876 to 1879, the last year named in the table, the figures constantly decreased.

It would be interesting in this respect to inquire whether the figures representing rum crimes are due to legislation wholly, or to vigorous or weak execution of law alternately applied, or to the positive decline of drunkenness through the efforts of reform movements. It is true that sentences for minor crimes and misdemeanors, and even felonious assaults and aggravated crimes, have risen or fallen, as indicated by the barometer of sentences for rum crimes alone. Legislative crimes—offenses which have been named crimes by legislative enactment—should not be used to show increase of crime in volume. Civilization has raised many things formerly considered as, perhaps, immoral and as offenses against the moral law to well-defined crimes. The result is, that we are constantly increasing the work of criminal courts; the number of sentences is thus increased comparatively, even when the volume of crime, as shown by the comparisons of crime *per se*, may decrease. So truthful statistics may show absolutely false conclusions, unless the elements are intelligently and honestly used.

Many illustrations as forcible as those cited might be drawn from the statistical work of the State and Federal Governments, but those given are sufficient to illustrate how dangerous truthful statistics may be; and to show, further, that the value of statistics depends upon not only the integrity of their basis, but also on their intelligent and honest analysis.

Another line of fallacies comes from the misuse of averages. Mr. W. L. Sargant, in his Essays published in London in 1870, has an exceedingly interesting chapter entitled The Lies of Statistics, and I am indebted to him to some extent for an illustration as to averages. The frequent fallacies in the practice of striking averages add greatly to the disturbing influences resulting from inaccurate enumerations, the perplexity and differences in international trade accounts, the miscalculations by individual inquirers, and the inadequate consideration of all the elements of tabular statements. M. Quetelet explained the principle which ought to guide us in the matter of averages. He pointed out that an average may indicate two different things. For instance, if one measures Nelson's Monument ten times, and always with a slightly different result, and then adds the measurements together and divides the sum by ten, the quotient is an average or mean. So one may accurately measure the Duke of York's Pillar, the Parisian obelisk, and the Column Vendome, add the measurements together and divide the sum by three, and declare the quotient to be the average or mean height of these three monuments. M. Quetelet contended, and properly, that the results in the two instances are of such different significance as to require two separate names. He would limit the term "average or mean" to cases represented by the first illustration—the repeated measurement of one monument—and he would apply the term "arithmetical mean" to cases represented by the second illustration—the measurement of several monuments. The repeated measurement of one monument results in a mean approximation to something actually existing, and this is an excellent definition of an average. The measurements and calculations having reference to a number of monuments result in no knowledge of anything existing; they simply and only indicate a relation among things actually existing. It is through a misunderstanding of these elements that we have so many misleading statements of statistics relating to wages and prices. The development of wage statistics has kept pace with all statistical methods. The great trouble is that, on account of faulty presentations in the past, no very satisfactory comparisons of the present conditions with the past can be made; and, generally speaking, those who use statistical comparisons covering a period of years should be exceedingly careful that the elements are approximately identical for the various years of the period.

Statistical science improves like all others, and this improvement is doing much to lead empirical statisticians into erroneous conclusions. The original faults of statistics are great enough, but the faults resulting from ignorant comparisons are greater still. On the whole, however, enormous as have been the errors, false as have been many of the statistical statements of official reports, inaccurate as have been many of the calculations, and fallacious and almost monstrous as have been many of the inferences, political economy has, nevertheless, profited greatly by what has been accomplished. The errors are gradually disappearing, and a very considerable remainder of truth has been left. We know far more than did our fathers of the progress of population, the resources of the nation, the earnings of the people, the cost of living, the efficiency of labor, more of criminal conditions, of mortality in town and country, of vagrancy and pauperism, of crowding and immigration; and, in fact, know more of all the conditions of life which make up sociology.* Legislators and philanthropists could ill spare their statistical guides, lame and delusive though they be, for "know thyself" applies to nations as well as to men, and that nation which neglects to study its own conditions and affairs in the most searching and critical manner must fall into retrogression. History is, indeed, statistics ever advancing, and statistics is stationary history. Science is best taught by examples of errors. This is to statistical art what a chapter of fallacies is to logic.

According to Mr. T. W. Cowan, as quoted in Nature, who has written of the natural history, anatomy, and physiology of that insect, the bee can draw twenty times its own weight; its flight exceeds four miles an hour, and it will go four miles in search of food. Its wings, braced together in flight by a row of hooklets, bear it forward or backward, with upward, downward, or suddenly arrested course, by a beautiful mechanical adaptation which is described in the book. Its voice organs are threefold: the vibrating wings, the vibrating rings of the abdomen, and a true vocal apparatus in the breathing aperture or spiracle. The first two produce the buzz; while the hum—which is "surly, cheerful, or colloquially significant"—is due to the vocal membrane. Some of the bee's notes have been interpreted: "Huumm" is the cry of contentment; "Wuh nuh-nuh" glorifies the incessant accouchements of the queen; "Shu-u-u" is the frolic note of young bees at play; "Ssss" means the muster of a swarm; "Brrr" the slaughter or expulsion of the drones; and the "Tu-tu-tu" of the newly hatched young queen is answered by the "Qua-qua-qua" of the queens still imprisoned in their cells.

The soundings of the Austrian vessel, the Pola, in the Mediterranean Sea, show that the water in the central basin of that sea is warmer, denser, and richer in salt than that of the western basin. As to transparency, a white disk was visible down to a depth of forty-three metres, but photographic plates were affected by light down to five hundred metres. No free carbonic acid was found in the water, and the amount of oxygen in solution was the same at the bottom as at the surface.

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* Compare Sargant's essay, The Lies of Statistics.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

VII. THE EVOLUTION OF THE WOOLEN MANUFACTURE (*concluded*).

By S. N. DEXTER NORTH.

Fig. 26.—A Greek Spinner of To-day.

WE shall dwell but briefly upon the dyeing and finishing branches of the wool manufacture. In dyeing, the ancients attained a degree of perfection so remarkable as to recall the saying of the prophet that there is no new thing under the sun. They discovered and utilized vegetable and animal dyes of blue, purple, and scarlet, so brilliant and so delicate that, with all our knowledge and experience, we are not able to surpass them. The chief advance in this department of the manufacture has been in the greater ease with which dyeing is effected, and the consequent reduction in its cost, and in the increased number of tints and shades which can be imparted to the material. The art of dyeing appears to have been contemporaneous with the arts of spinning and weaving. Where these flourished, there the dyer always left behind him the evidences of his skill; when these languished and decayed, dyeing became one of the lost arts. The ancient Tyrians attained their celebrity as the most skillful dyers of antiquity by their use of the liquid of the shell-fish *buccinum* and *purpura*, while the early explorers of this continent were astonished at the brilliancy of the dyes which the Mexicans and the Peruvians extracted from forest trees. In the Peruvian department at the Philadelphia Exhibition there was exhibited a piece of woven cloth, taken from the tomb of the Incas, which had retained, for more than two thousand years, its original colors scarcely dimmed. Modern dyeing must stand abashed in the presence of such evidence of a permanency it does not pretend to imitate. But it has made some wonderful advances, all within the last quarter of a century, in the successful application of the aniline dyes to fabrics; and the new combinations which are constantly evolved and applied, are all of them possessed of this great advantage, that they are brought within the reach of the millions.

Wool has an affinity for dye surpassing that of any other fiber, and there is no new discovery in dyeing material to which it does not instantly declare kinship. It is dyed to equal advantage either in the fleece (after scouring), the sliver, the yarn, or the piece, according to the use to which it is to be put. The dyeing department of a great wool-factory is one of the most critical points of its administration. Here again art touches manufacture closely. The designer and the dyer are the two agencies through which the manufacturer keeps in touch with the world.

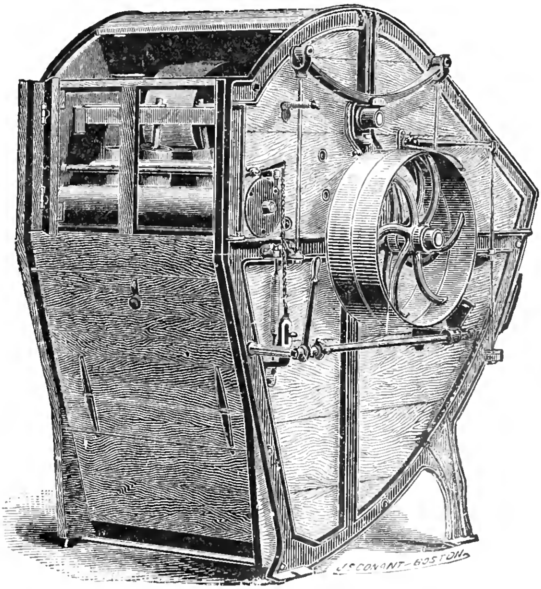

Fig. 27.—Rotary Fulling-Mill.

The finishing of woolen goods is a series of operations no less important than those which have preceded, for they determine the final appearance of the textures. These processes are numerous and delicate. They have been vastly simplified and expedited by machinery, and chiefly in the last half-century. The most important of the finishing operations is that of fulling or milling. In this operation the cloth will lose by shrinkage from one quarter to one third of the length and breadth to which it is woven. The serrations of the wool, which have been left intact throughout the multitudinous manipulation to which the fiber has been subjected, fit into each other in the process of milling, and lock fast under pressure. Thus a piece of woolen cloth, originally a series of threads loosely woven, becomes apparently one solid mass, which can be pulled apart with difficulty. Fulling can only be accomplished when the cloth is damp, warm water and soaps being used to facilitate it. There appears to be no limit to the felting capacity of wool or the shrinkage which may accompany it.

By the most primitive methods the fulling was done in tubs under the pressure of the feet, a tedious process, requiring several days. In the early days of mechanical manufacture the cloths, after boiling or scouring to remove the oil, were folded in laps, hammered, refolded, and again hammered five or six times, until the fibers had matted and shrunk to the desired size. At a later period there followed a primitive method of automatic fulling, in a milling trough, with "stocks," which were two heavy wooden mallets, lifted in succession by cogs fixed on the axis of a water-wheel. These hammers would make from thirty to forty blows a minute, and the process was repeated four or five times, with intermediate soapings and rinsings, occupying a day to complete it.

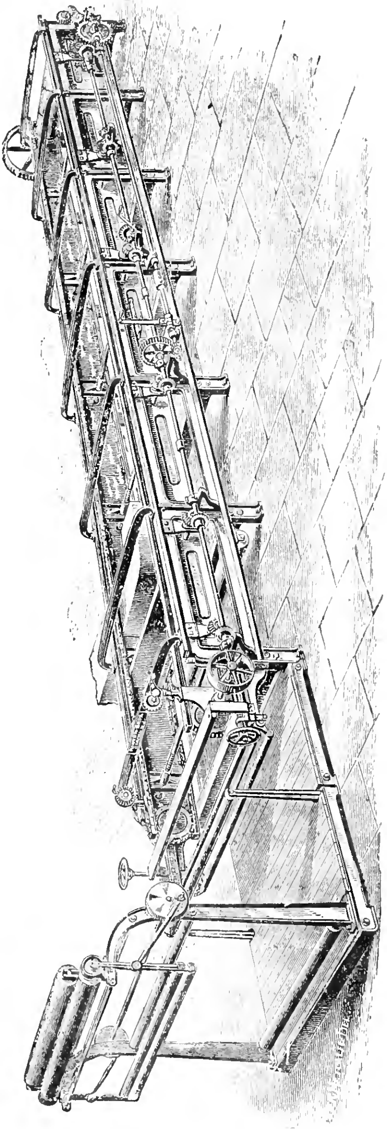

Fig. 28.—Hot-air Drying and Tentering Machine.

The fulling-mill with rollers is an American invention, that of John Dyer, whose patent bears date 1833. The invention of the double crank-shaft fulling-mill was also of American origin, Levi Osborne's first machine, made in 1804, being the first of a series of valuable machines on that principle. By the use of the new methods of fulling, the cloth, after saturation with soap and water, is passed between two vertical rollers in a twisted condition, the pressure applied causing it to shrink in the direction of the weft. As the cloth passes through these rollers its progress is interrupted at intervals, and it is held in a trough or case which causes the fabric to shrink in the direction of the warp. The first closed cylindrical fulling machine came into use about 1844. By its use this important branch of the work was executed with a precision and certainty hitherto unattainable, while much economy of room and saving of heat were effected by suppressing the old fulling machines.

After rinsing, tentering or dry stretching follows. In our older mill-yards may still be seen the tenter posts and hooks, upon which the cloth was stretched and left for several days to dry in the open air. This operation is now quickly performed by the use of revolving frames and steam coils. Raising follows, to open and disentangle the fibers, completely covering the surface of the goods after milling and tentering. The "nap" is raised by the use of the teasel, which earlier manufacturers set in a frame, having crossed handles, and scratched over the surface of the cloth. This frame formed a tool not unlike a curry-comb in appearance, and was used by two men, who scrubbed the face of the cloth as it hung in a vertical position from horizontal rails fixed to the ceiling of the workshop. The machine upon which this work is now done is called the raising-gig. It is a large cylinder, containing a number of iron rods closely set with teasels. It travels rapidly, in a direction opposite to the movement of the cloth, which, moving slowly, is brought in contact with the sharp and pliant teasels, which raise the fibers by a series of rollers, capable of adjustment according to the amount of nap it is desired to raise. The gigging machine also, while not originally an American invention, has received from Americans its most valuable features. As early as 1794 Walter Burt obtained in America a patent for a gigging-mill in which the rotating barrel was the distinguishing part; and the names of Jersey, Christie, Olney, Barrows, Beck, and Wells are honorably identified with its subsequent development.

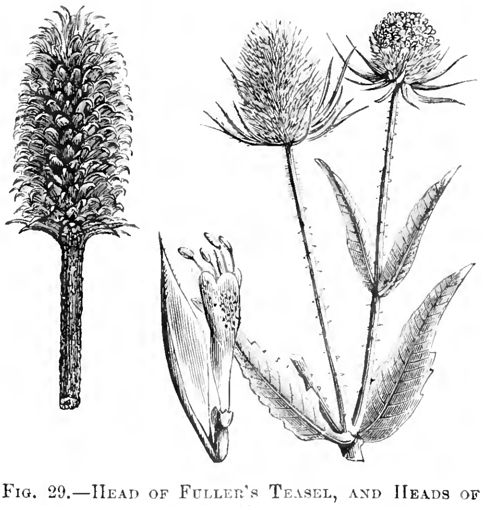

Fig. 29.—Head of Fuller's Teasel, and Heads of Wild Teasel.

The process of cutting off at an equal height all the filaments on the surface developed by napping was performed in the middle ages by the use of enormous scissors, and this method was continued, with but slight modifications, down even to the present century. It was slow, laborious, and extremely painful to the workmen who were compelled to operate the shears. The principle of the machine now used for shearing cloth is a cylinder armed with a knife arranged in a helix—a sharp screw turning tangentially in contact with a fixed knife and the cloth upon which the latter rests. Eleazar Hovey, of Canaan, Conn., patented a shearing machine in 1811; and this invention was introduced into France in 1812 by George Bass, of Boston, Mass., and there and everywhere is ranked among the most important of the inventions which have brought the woolen manufacture to its present high state.

Following the shearing, which fine cloths, like broadcloth, undergo twice and three times, are boiling and crabbing. Cloth that is to be "dyed in the piece" now takes its turn in the dye-house, and is run through the dye-kettles in an endless belt over cylinders, as in fulling. Crabbing is a process of scouring by steam, applied separately to each side of the cloth by rolling it upon large metal cylinders, and then rewinding the cloth, reversed, to give it the surface preparatory to dyeing. The process of inspection, called "perching," intervenes at one point or another, according to the fabric, by which any defects in the manufacture are noted. Knotters and burlers remedy these defects, removing knots left by the loom, and mending broken threads. Finally comes the pressing, by which the final finish and luster are given to fine cloths. Until quite recently pressing was done by folding the cloth in layers between boards of smooth pasteboard and pressing them between hot plates in hydraulic presses. A machine now expedites this process by compressing the cloth between rollers heated by steam. The inventor of the pressing machine with steam was Seth Hart, who received a United States patent in 1812. This invention appears twelve years later in Europe, John Jones taking out an English patent for the same machine in 1824. It appears that John Beverley, an owner of woolen and cotton factories in the United States, made the first use of the hydraulic press in 1803. He named it a "hydro-mechanical press." Bowker and Hall, of Boston, constructed a rotating cylinder press, heated by steam, in 1814, which is believed to have contained the first idea of the steam cylinder cloth-press now so universally used. The finishing operations to which worsteds are subjected differ slightly from those applied to woolens, with less of fulling and sometimes with none. Singeing machines are often utilized here, in which the fabric is passed over copper plates, heated to a white heat, so quickly and deftly as to burn from it only the excrescences, leaving the tissue itself unscorched and perfect. Thus completed, the goods are finally boxed and ready for the market.

Dr. Grothe, the distinguished German investigator of textile evolution, has testified that the contributions of American inventors to finishing machinery exceed in extent and value those of any other nation; and he adds that, as a result of his investigations, he is "happy to award the merit of priority in invention, frequently claimed for England, to America, the country which has created inventors through her system of home industry and personal liberty."

We have now completed our tour of the woolen-mill and our hasty examination of the machines which have superseded the earlier inventions in these establishments. Not less striking than their wonderful ingenuity is their multiplicity. We find not only a separate machine for each of the twenty-three different operations enumerated by Ure in 1834, but we also find, in the larger mills, great numbers of these separate machines. A modern factory is, therefore, something almost entirely different from anything which existed a century ago. It contains vast rooms, each devoted to separate branches of the industry. In one we find the scouring machines; in another, the carding machines; in another, if it be a worsted-mill, the combs and gilling machines; in another, long rows of whirling spindles tire the eye, and in another the clatter of hundreds of looms suggests pandemonium. Everything is systematized, and the surroundings of the operatives, with abundance of light, with perfect ventilation, with steam-heat, with convenient retiring-rooms, justify the statement that the gain of the manufacture through improved machinery is no greater than the gain of the operative, which has come through the accompanying improvement in the construction and arrangement of the buildings in which these operations are conducted.

The Wool Manufacture in the United States.

The development of the wool manufacture in the United States occupies a unique relation in this narrative. It is contemporaneous with the period of the actual mechanical florescence of the industry. Up to the time when our independence was asserted, we were a nation dependent upon our household industries and our foreign commerce. We used but little cotton—that little, strange as it now seems, being imported. Men and women were clad in homespun, spun and woven on the domestic wheel and loom. Almost every man was literally his own weaver. The earliest records show that the subject of their clothing was an object of solicitude to the primitive law-makers of the colonies. They were without any raw material whatever. They found no important fiber indigenous here, and their solicitude was great to domesticate sheep.

The first approach to a woolen-mill in the colonies of which

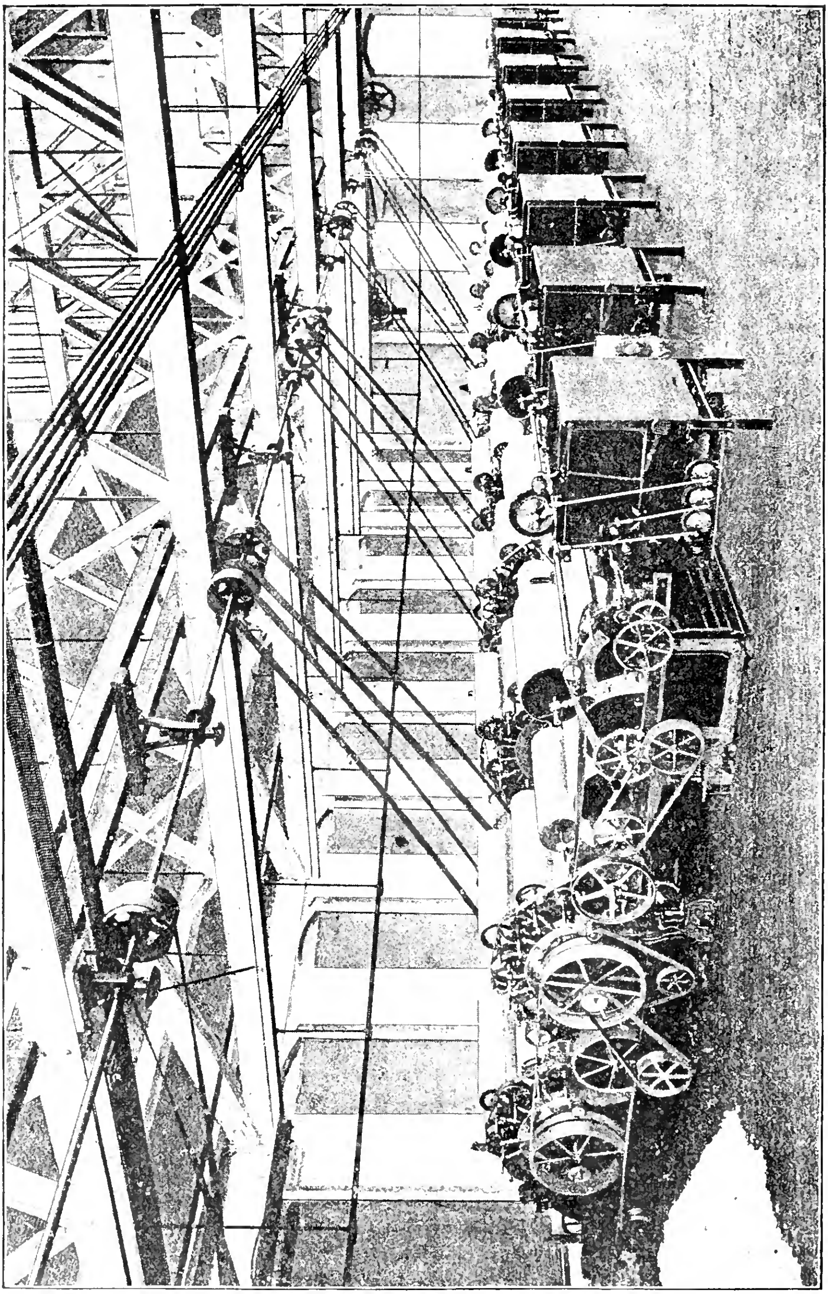

Fig. 30.—Section of a Worsted Card-Room.

there is any record was a fulling-mill at Rowley, Mass., built in 1643, with gearing imported from England. Twenty or more families, trained in the cloth manufacture of Yorkshire, had settled in this town, and essayed to earn their livelihood by their art. But the industry, there and elsewhere, was essentially of the home, and never went far beyond it, notwithstanding the pains which the General Court of Massachusetts took in 1656 to foster spinning by penalties. "Fearing that it will not be so easy to import clothes as it was in past years, thereby necessitating more home manufacture," the General Court ordered the selectmen in every town to turn the women, girls, and boys to spinning and weaving, each family to be assessed for one or more spinner, or fractional part, according to its size, and "that every one thus assessed do after this present year, 1656, spin for thirty weeks every year three pounds per week of linen, cotton, or wooling, and so proportionately for halfe or one quarter spinners, under the penalty of twelve shillings for every pound short." Legislation of this character shows how promptly the colonists recognized the advantage that must accrue to them from independence of the mother-country in their clothing supply. It also shows them apt pupils of the English system of stimulating special industries by patriarchal legislation. The stimulation thus effected was not without its results. The increasing production of home-made fabrics, while it still supplied hardly a twentieth of the needs of the colonists, nevertheless alarmed the home Government toward the close of the century. In 1699 a stringent decree was laid upon the movement of all woven fabrics within or without the plantations. The manufacture was not prohibited, but nothing was left undone to embarrass and check colonial enterprise in the pet British industry of wool manufacture. This prohibition extended to "wool, woolfells, shortlings, morlings, worsted, bay or woollen yarn, cloath, serge, bays, kerseys, says, frizes, druggets, shalloons, or any other drapery, stuffs, or woollen manufactures." This enumeration reveals something of the character of the goods the colonists were then making around their firesides, and of the names then applied to them.

Following the industry down through the eighteenth century, we find little or no modification of the primitive conditions indicated above. At the anniversary of the Boston Society for the Promotion of Industry and Frugality, August 8, 1753, three hundred "young female spinsters" spun at their wheels on the Common, and the movement for popularizing the home industry went so far as to be nicknamed "the spinning craze." In 1766 Governor Moore reported that there were two kinds of woolen made in the province of New York; "one coarse, of all wool, the other linsey-woolsey, of linen in the warp and wool in the weft." The Stamp Act troubles afforded a distinct stimulus to the industry, and appeals to patriotic pride in the weaving of home-made clothing were common. The president and first graduating class at Rhode Island College are immortalized in history by their appearance on the stage clothed in fabrics of domestic manufacture. Premiums were again offered to encourage both the growth of the raw materials and their manufacture. Ladies' meetings for patriotic spinning were inaugurated in various colonies, and these continued down to and into the Revolutionary War.

With the outbreak of that war, serious attempts at the manufacture of woolen goods in factories began. Samuel Wetherill was regularly engaged in the manufacture of woolen fabrics in Philadelphia about the beginning of the Revolution, and had a contract with the Provincial Congress to supply army clothing. In 1776 Edward Parker received three hundred pounds from the Maryland Legislature to assist him in the manufacture of woolen and linen goods. He had five looms. Charles Carroll, the signer of the Declaration, had a similar establishment. Neither of these parties, in all probability, used any power. The first mill in which power was used was the Hartford Woolen Manufactory, established in 1788 by a company of thirty-one gentlemen, most of them Hartford merchants. The factory was erected on a small stream, whose power operated two carding machines. For several years this factory achieved an annual output of five thousand yards of cassimeres and broadcloths, worth about five dollars a yard. An Englishman named Wansey, who visited this country in 1794 and inspected the mill, wrote that these cloths could be sold for about the same price as English goods, delivered in the stores at Hartford, "but the fabric was very poor and hard in the spinning, and dearer than the British, loaded with all the expense of freight, insurance, merchant's profits, and nine and a half cents duty." The Hartford company could not compete with the English cloth, even with these advantages, as its early collapse proved. While it lasted, it was quite the sensation of the country round about. General Washington's visit to the factory in 1789 is minutely recorded in his journal, and the patriotic spirit was stirred by the fact that he appeared at his first inaugural clad in a suit of broadcloth presented by the owners of the mill. General Washington noted the fact that "all the parts of the business are performed at the manufactory except the spinning—that is done by the country people, who are paid by the cut." It was to this factory that Hamilton alluded in his celebrated report on manufactures. Another woolen factory was established at Stockbridge in 1789, and another at Watertown in 1790. The three mills had a capacity of about 15,000 yards per annum, valued at $75,000. In contrast with these figures we have the official value of the woolens exported from England to the United States in 1799 at £2,803,490,* or more than two fifths of that country's total

* Bischoff, vol. i, p. 270.

woolen exports, no other country even approaching our own as a consumer of English woolens. No wonder Great Britain took drastic steps to preserve this splendid market.

Neither of these pioneer enterprises was a success, either mechanically or financially. The machinery was imperfect and inadequate, and the projectors learned by sad experience that they could not equal the British fabrics either in quality or in price. The Hartford factory struggled along until 1795, when the machinery—consisting of eight looms, two carding machines, one spinning jenny, one twisting machine, and other odd implements—was sold at auction.

The year before the collapse of the Hartford factory the first incorporated woolen company in the United States began operations at Byfield, Mass. The Byfield factory was operated for five years under the superintendence of John and Arthur Scholfield, two ingenious Englishmen, who are commonly spoken of as the first woolen manufacturers in the United States, in the same sense that Samuel Slater is described as the pioneer cotton manufacturer. It is certain that theirs was the first instance of a successful woolen manufactory with improved machinery of a character which entitled it to rank with the mills which were plentiful in Great Britain at the date of which we are speaking. The Scholfields introduced a new carding machine, of their own construction, based upon the machines they had seen in operation in their native land. It was adapted to water-power, and the beginning of the new era of woolen manufacture in the United States fairly dates from it.

For many years prior it was vaguely realized in the United States that the world was upon the eve of a new and strange industrial development, from participation in which this country seemed to be excluded by laws designed to keep it industrially dependent. Tench Coxe states that he first became aware in 1786 that labor-saving machinery for spinning was being largely used in Great Britain, and he then made unsuccessful efforts to obtain models of these machines. The mother-country, thoroughly awake by this time to the significance of the textile inventions of her citizens, had passed laws by which she hoped to retain the monopoly of the rich harvest their ingenuity promised. The first of these statutes, enacted in 1774, a few years after Arkwright's successful inauguration of the factory system with his new appliances, was entitled "an act to prevent the exportation to foreign parts of the utensils made use of in the cotton, linen, woolen, and silk manufactures of this kingdom"; and its purpose, as set forth in the preamble, was "to preserve as much as possible to his Majesty's British subjects the benefits arising from these great and valuable branches of trade and commerce." The statute pro-

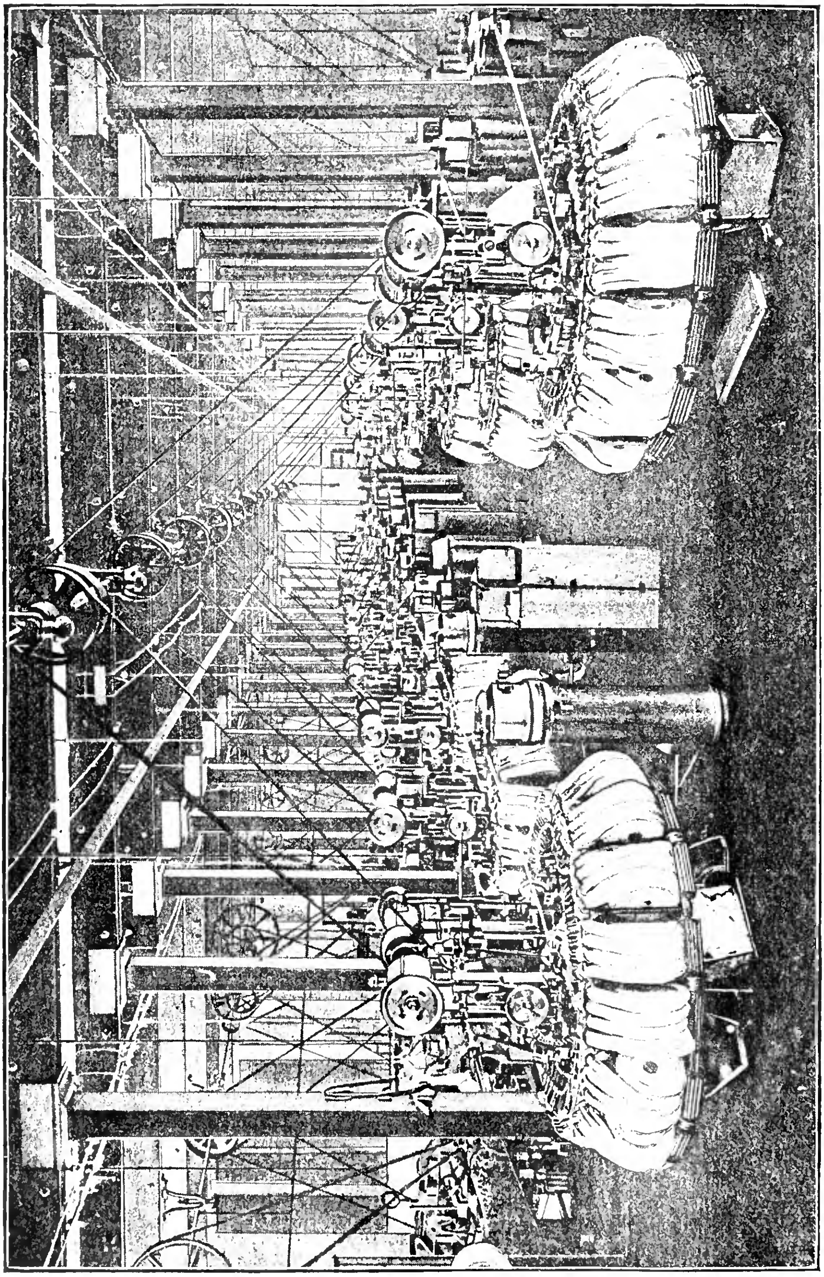

Fig. 31.—A Combing-Room.

hibited, under penalties of forfeiture and heavy fines, "the putting on board of any ship or vessel, not bound to some port or place in Great Britain or Ireland, of any tools or utensils commonly used or proper for the preparation, working up, or finishing of the cotton, woolen, silk, or linen manufacture." Another statute, even more stringent, was enacted in 1781, by which a year's imprisonment was added to the penalties of forfeiture and the fine of £200 previously imposed. This policy was rigorously enforced, notwithstanding some modifications of the law in 1825, and again in 1833, until the year 1845, when machinery for the textile manufactures was for the first time omitted from the list of prohibited exports.

No known instance occurred during the earlier decades of the enforcement of these laws in which a perfect textile machine was smuggled into this country. Some few models were clandestinely introduced, but they were of so imperfect a character that it may literally be said that the United States was compelled to invent anew the machinery with which, gradually, and after a most trying probation, her textile industries were finally established. The more remarkable is it, therefore, that this country learned so quickly how to clothe itself, and maintained and developed a great woolen industry in the face of a nation which had such a tremendous start in the race.

No circumstances could have afforded a greater incentive to the inventive faculty of a young and ambitious people. Very soon it was at work; very rapidly it traversed the ground already covered in England; and very naturally it has happened that the inventors of the United States have supplied the world with many of the most important of the inventions which have accelerated the development of the textile arts.

For many years the carding machines formed an important part of the fulling-mills of the clothiers of the early part of the century. As late as 1810 the trade of the clothier was as distinct as that of the hatter, although both have nearly disappeared. In New England nearly every township had its carding and fulling mill, the machinery being moved by power. The wool was carded into rolls, to be spun in the household, at a cost of about seven cents a pound, and the cloth, after having been woven in the families, was fulled and dressed by the clothier.* In Vermont, in

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* This was not always the case, however. Judge Johnston, of Cincinnati, in his address before the Pioneer Society of that city in 1870, gives the following graphic picture of a method of home-fulling which, he says, prevailed throughout Ohio early in the century: "When the wool became abundant the method of scouring and fulling blankets, flannels, cassinets, and even cloths, was simple. Every house had hand-cards, and as many spinning-wheels as spinners, and no respectable house was without a loom. When the goods were carded, spun, and woven, then came the kicking frolic. Half a dozen young men and as many young women [to make the balance true] were invited. The floor was cleared for action, and in the middle was a circle of six stout splint-bottom chairs, connected by a cord to prevent recoil. On these sat six young men with shoes and stockings off and trousers rolled above the knee. In the center the goods were placed, wetted with warm soap-suds, and then the kicking commenced by measured steps, driving the bundle of goods

1810, 1,040,000 yards of cloth and flannel were woven in families and dressed in these mills. In 1840 there were 2,585 fulling and carding mills in the United States. Forty years later this number had been reduced to 991; and, in the decade since 1880, the mortality among them has been even greater. In the mills which still remain, on the outskirts of civilization, the operation of fulling has been almost wholly abandoned, and custom-carding only is done for the neighbors who still spin and weave their homespun.

Of the early stages of the introduction of wool-spinning machinery in this country the records are exceedingly deficient. Spinning jennies, built by Arthur Scholfield as early as 1806, were the first actually utilized in this country, and are described as containing from twenty to thirty spindles, upon which a single woman could spin from twenty to thirty runs of fine yarn a day "in the best manner."* These jennies cost about fifty dollars' and were operated by a crank moved by hand. In the history of the oldest woolen manufactory in Rhode Island, the Peace Dale Company, founded by Rowland Hazard in 1802, spinning and weaving were carried on wholly by hand, until about 1819, when a spinning jack of fifty-two spindles was operated.†

The power-loom for weaving broad goods was not introduced until 1828. The date of 1830 has been fixed upon by Dr. Hayes as marking the successful introduction of the woolen manufacture in this country substantially with the principal appli-

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round and round; the elderly lady, with long-neck gourd, pouring on more soap-suds, and every now and then, with spectacles on nose and yard-stick in hand, measuring the goods till they were shrunk to the desired length. Then the lassies stripped their arms above the elbows, rinsed and wrung out the blankets and flannels, and hung them on the garden-fence to dry."

* The Philadelphia Magazine or American Monthly Museum for 1775 describes and illustrates what it calls "the first spinning jenny introduced in this country" and made by Christopher Tully in that year. The editor says of it: "The machine for spinning twenty-four threads of cotton or wool at one time (by one person) having attracted the notice of the public, and we being desirous to contribute everything in our power toward the improvement of America, engaged Christopher Tully, the maker of the machine, to furnish us with an engraved plate and description thereof. . . . We have seen the machine perform and are convinced of its usefulness. The Society for the Improvement of Arts, Manufactures, and Commerce in England repeatedly offered a premium of £100 sterling for a machine on this plan, but never had any presented to them which would answer the purpose. Notwithstanding which a very large one has been erected at Nottingham, in England, which performs to great advantage, but no person as a speculatist is admitted to see it."

† Mr. Hazard has shown the progress of thirty years in the following statement: "In 1816 and later I used to employ scores of women to spin at their homes at four cents a skein, by which they earned twelve cents a day at most. The wool was carded into rolls at Peace Dale and transported to and from on the backs of horses. Some time ago I stood in a manufactory in the same village and took note of a stripling who tended two highly improved jennies, from which he was turning off daily as much yarn as six or seven hundred formerly spun off wheels in the same time."

ances and machinery of the present day. This was the date of the erection of the Middlesex Mills, of Lowell, of whose history it has been written that "it covers the entire life of the successful woolen industry of this country." In the earlier days of our manufacture, the products of our mills were chiefly the coarser fabrics. Until about 1840 they consisted almost wholly of satinets, flannels, and blankets. The manufacture of fine broad cloth was indeed early attempted, and with considerable success. Gradually, amid many vicissitudes, and with great loss of capital, large mills were established and succeeded in maintaining themselves and in diversifying the industry.

We shall not attempt to state the statistics of this development. They are accessible in the census reports to those specially interested. By 1880 the product of all our mills, employed in the manipulation of wool in any form, was stated at $267,000,000, and the census of 1890 will show this product not far, if any, short of $350,000,000. Next to England the United States is to-day the largest wool manufacturing nation, and the people of the United States consume a much larger quantity of wool per capita than any other people. Indeed, the increasing capacity of our woolen-mills barely keeps pace with the increasing consumption of our people.

Economic Aspects of the Evolution.

The evolution of the wool manufacture has had an economic influence upon civilization more marked even than that which has to do with the cost of clothing. Indeed it is a disturbing element, in estimating this reduced cost, because that which was once fabricated at home, by the members of the family, the labor of some of whom at least would otherwise have counted for nothing, is now bought in the shops. This evolution has substituted the factory system for the household industry, almost obliterating the latter in all countries which are within reach of commerce. We have seen how important an element in the household economy of the American colonies and the early republic the making of the cloths for clothing was. It was of even greater importance in England and France, and particularly in England, where, up to the introduction of automatic machinery, the handling of wool, both for domestic use and export, continued to be the most important occupation of the people next to agriculture, with which it was so closely allied. We can trace the gradual development of the old English system into the new. The founders of the great houses which now conduct the industry were, many of them, the hand combers or spinners or weavers of the primitive industry. They were the forehanded among these laborers, who gradually took others into their employment, and, as machinery came into vogue, were able to utilize it. Thus the minute subdivision of the household industry has been duplicated in the English factory system. The scouring of the wool is done by one establishment, the carding and combing by another, the spinning by another, the

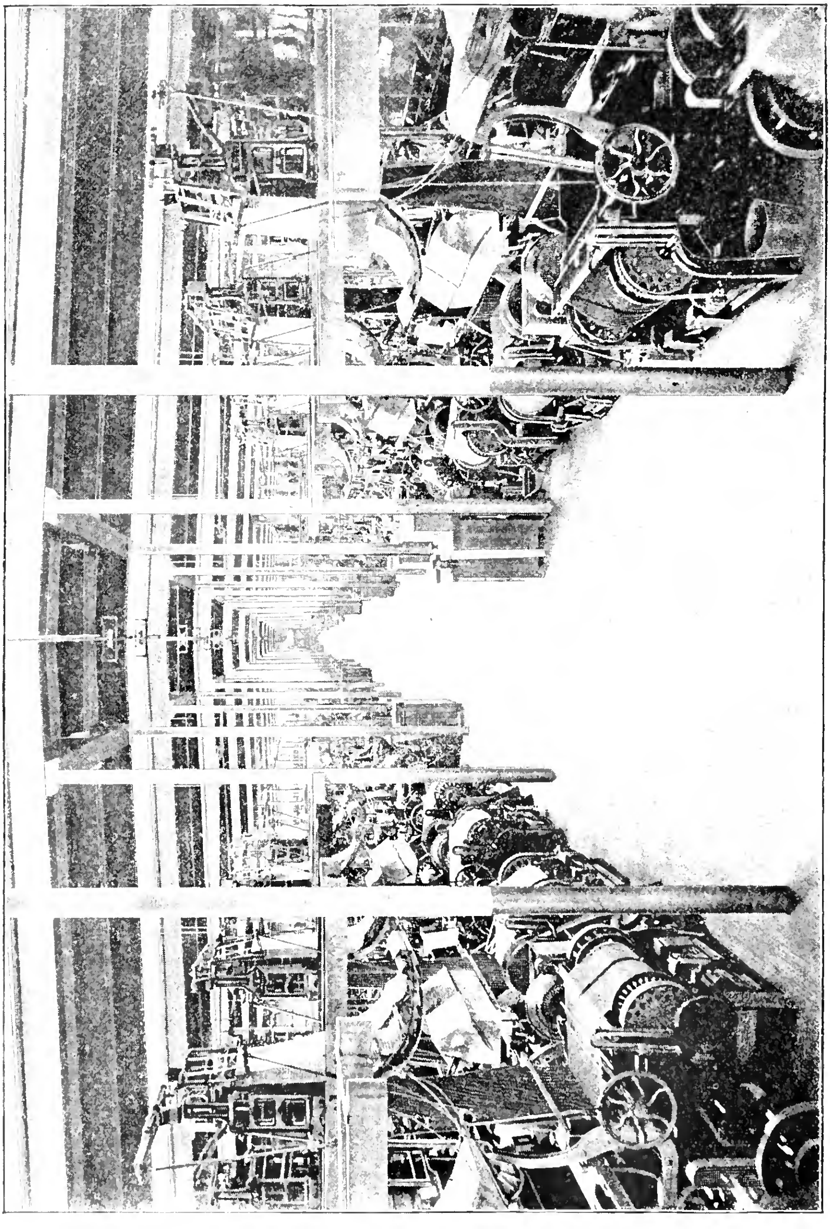


FIG. 32.—A WEAVE-ROOM.

weaving by another, the dyeing and the finishing by still others; while the packing of the goods for the market often constitutes still another distinct subdivision of the business. While this minute subdivision of the industry is largely the outgrowth of conditions rather than a tendency evolved from experience, it may be said to be definitely determined that the best results are attained by it. Under this system a community like Bradford in England is a great beehive of interdependent industries, the separate stages of the manufacture being carried on in separate establishments. The whole energy of the management, in each branch, is devoted to securing the best results in that particular branch under the most economical conditions. Here, in a radius of 75,000 acres, with a population of 500,000 people, is consumed nearly or quite one half of the total quantity of wool worked up in Great Britain. Here a capital of £40,000,000, employing 140,000 operatives, turns out each year a product of manufactured wool valued at nearly the total amount of its capital. Here, built up within the century, is an aggregation of organized industrial development without a parallel among the princely cities of antiquity—the most striking, the most tangible, of the many results of the evolution of the wool manufacture. The complete organization of the Bradford manufacture indicates the ultimate development of the industry.

It is not difficult to understand why the development of Great Britain and France, in this particular, with its striking concentration of the textile industries in towns like Bradford, Huddlesfield, Manchester, and Leeds, and Rheims and Roubaix, has not been duplicated in the United States. While the factory system here has superseded a household industry, it is in no sense an outgrowth from it. We have seen why not, in the difficulties which attended the procurement of machinery in the early days of manufacture here. The first factories were stock companies, necessarily, for few individuals had the capital necessary to found mills. These original mills performed all the operations of the manufacture, because there were no agencies through which any part of these operations could be independently carried on. Water-power being then the great desideratum, they were widely scattered on the streams of the New England and Middle States. This scattering created the necessity for the equipment of complete mills under one management. Time is gradually effecting something of a concentration of kindred industries, as in Philadelphia, which is called the textile center of the United States, and in New England towns like Fall River, Lawrence, and Lowell. With this concentration, there is gradually evolving a system of subdivision. This tendency we may look to see increase in the wool manufacture, with a corresponding gain in the stability of the industry, and in the variety and the excellence of its products.

Surveying the whole field, we are struck by two features in this evolution, the combination of which includes the sum of the advance. Not less wonderful than the succession of power-machines for the automatic handling of the fiber in the several stages of its manipulation, is the series of mechanical contrivances for the automatic delivery of the material from machine to machine without the touching of human hand. The ingenuity of man has been constantly directed, in these latter years, to devices for the accomplishment of two purposes: first, to increase production; second, to diminish waste. Both tend to reduce the cost to the consumer, the first by reducing the number of operatives required to make a given amount of product and by increasing the productive capacity of machines otherwise perfect. Perfect as these machines now appear to be in their operation, every one among them is susceptible of improvement, and the patent offices of every manufacturing nation are burdened with the plans and specifications of new devices, conceived by the bright mechanics who abound among the operatives, and suggested generally by their daily work and observation, the purpose of which is to add either simplicity or celerity, or to still further reduce the necessity for handling.* Most of these inventions come to naught; many of them are constantly introduced into the mills. Some few of these advances not previously spoken of may be enumerated here. Self-feeders on the first breaker and finisher have been applied to card machines, dispensing with half the help formerly necessary in the card-room. Self-operating mules have been introduced in cloth-mills, effecting a saving of from twenty to forty per cent in the cost of spinning. Improved winders, driers, and cloth-presses give greatly increased rapidity to the processes of finishing. In weaving flannels, a width of three yards at once, seventy-five or eighty picks a minute are woven as economically and as excellently as forty or fifty picks were thirty years ago. In making cassimeres, the broad loom has been generally substituted for the narrow loom almost universally employed as recently as 1860. Fifty-six yards of Brussels carpet can now be woven in a day by one girl, in the improved looms, where fourteen yards a day was a good product in 1860, with the same help. Similar illustrations might be multiplied almost indefinitely. While there has been no new departure or novel idea of transforming effect in the wool manufacture, the general advance in mechanical efficiency, during the last quarter-century, has been so great as to equal an economical gain in manufacture equivalent to that which took place when power was first substituted for hand-labor. In our great yarn-

* The records of the United States Patent Office, from its founding up to July, 1890, show a total of 8,890 patents issued for textile machinery, divided as follows: Felting and hat-making, 1,231; carding, 1,194; knitting, 1,189; spinning, 1,921; weaving, 2,954; cloth-finishing, 401.

mills there is constant progress in the direction of an increased product, of a finer quality, from the same machinery. The standard of productive capacity is thus shown to be variable, dependent in a perceptible degree upon the ability of the management to get the best results from a given capacity. The obvious advance in the future is in this direction. We can hardly look for any radical new departure in the mechanism of wool manufacture, such as occurred with the introduction of automatic spinning, the combing machine, and the power-loom. At the same time it would be foolish to assert that some new mechanical discovery, which may be at this very moment lying fallow in the brain of an unknown genius, will not work another revolution as complete as that which marks the transition from the household to the factory system. We can not, for instance, doubt that electricity is to work its wonders in this department of human industry as well as in every other.

This paper may properly conclude with some indication of the nature of the world's gain from the evolution of the wool manufacture. It is difficult to obtain a proper standard for such comparison. Statistics, even were they obtainable, present the contrast very inadequately. The total gain secured over hand-labor can hardly be estimated at an absolute value, for the present efficiency can not be obtained. In the principal operations of the manufacture the increase has been about as follows: In olden times a woman could card one pound of wool a day by hand. At present one operative, with the necessary machinery, can card one hundred to one hundred and fifty pounds a day. Hence the improvement is about one hundred and twenty-five. On a spinning-wheel a woman could produce daily two skeins. An average mule to-day spins about five hundred pounds; hence the improvement is about five hundred times. On a hand-loom it took a day to weave two to three yards. Power-looms produce from thirty-five to fifty yards a day, or an improvement of seventeen. Hence, disregarding all other factors but these, and placing a modest estimate, it is possible at present, with power machinery, to produce over seven hundred times more goods to-day than in the olden time, with the same number of hands, disregarding the quality, design, etc. This enormous gain can hardly be stated by periods. It has practically been achieved in a single century. In 1800 it was declared in the British Parliament that thirty-five persons could then accomplish, in the wool manufacture, with the aid of machinery, what would have required the labor of sixteen hundred and forty persons in 1785. That was equivalent to the statement that one person could then do the same work that forty-seven had done fifteen years earlier.

We have already alluded to the last half of the eighteenth century as marking a greater advance in the textile industries than all the centuries preceding it. The range of improvement in the present century covers the whole ground of the evolution, except the bare principle of automatic or mechanical manufacture, which was still in its infancy in 1800. The nineteenth, therefore, outranks even the eighteenth century in the economic progress which distinguishes it. Of this tremendous advance the most important steps, so far as relate to machinery for expediting processes, economizing help, and performing complicated operations automatically, have occurred in the latter half of the present century.

The individual capacity of the operative, thus enormously increased by machinery, has been accompanied by an increase in the total number of persons solely occupied in the manufacture of wool. The number who were thus employed in the period of household industry can not, of course, be estimated. But a vastly larger number of persons now depend directly and solely for their livelihood upon employment in woolen-factories than was ever the case before the introduction of power machinery and the factory system, and they are able to earn quite double the wages of the hand-operative of olden times.* It follows that the increase in

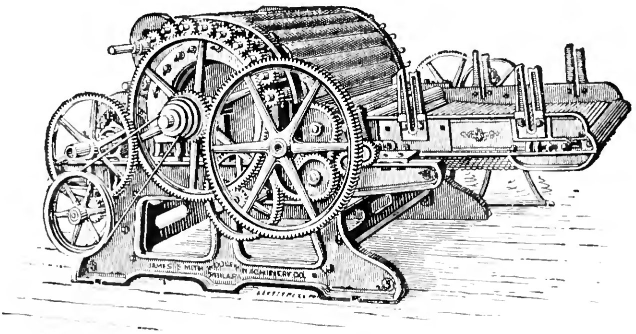


Fig. 33.—A Garnett Machine.

the production of woolen goods to-day is very much greater than would be indicated by the fact that the labor of one operative is now equivalent to that of one hundred operatives one hundred and fifty years ago. This deduction is borne out by the extraordinary increase in the world's wool-clip. It is safe to put the annual product of wool at 2,000,000,000 pounds in the greasy state. Of this amount nearly one half comes from three countries—Australia, South America, and South Africa—whose wool-clip is a

* The hand-loom weaver in the United States never earned more than fifty cents a day, and in earning it he was compelled to exert himself physically to a degree not approximated in the management of a power-loom.—Carroll D. Wright.

development subsequent to, and undoubtedly caused by, the substitution of machine for hand manufacture. The clip of the United States has increased from a few hundred thousand pounds, at the time of the Revolution, to over 300,000,000 pounds, and the product of the continental countries has also increased very greatly in the interval.

To fully realize the quantity of raw material now consumed in what are commonly known as woolen goods, we must estimate the quantity of waste and substitutes utilized as equal to that of wool; and thus we have 4,000,000,000 pounds of raw material passing annually through the looms of the world. Hand manufacture knew no such thing as a substitute for wool. The raw material has only been kept abreast of the manufacturing capacity by the discovery of methods for the utilization of these substitutes.

Something of what the world has gained in quantity has been lost in quality at certain points. It can not be pretended that the utilization of wastes and substitutes does not involve a certain element of deterioration. Nevertheless it is a distinct gain to the world, as is every new development that reduces the waste in any branch of industry. Within a few years a machine has been invented, known as the Garnett machine, which enables manufacturers to comb out all their waste, whether from cards, mules, spinning-frames, or from whatever source tangled and twisted fibers are produced in the various processes of manufacture, and to so restore it that it may be again utilized in connection with the original fiber. The saving thus effected is enormous. The machine, as the illustration shows, is in principle the same as the carding-engine. Its strong, sharp-pointed, steel teeth gradually untwist and teasel out the kink in yarn or thread, restoring the fibers of wool in nearly their original length of staple.

The fiber of wool has a wonderful capacity of endurance. Once used it may be, and is, used again and again, reproduced, not with all its original virtues, but still with many serviceable qualities, and called, according to its form, shoddy, mungo, waste, wool-extract. The French, by a happy conceit, call this material *renaissance;* and it is literally wool born again. By chemical processes the wool in mixed goods is separated from the cotton or other fibers employed for its adulteration, and wonderful machines tear it apart, readjust its fibers, and prepare it again for the spindles. Thus it goes into new garments, of a cheap grade, to be sure, but, if properly prepared, of a serviceable quality. It is customary to speak contemptuously of shoddy and of those engaged in its manufacture and use. But those who do so do not understand how important is the part now played by this preparation in the cheapening of the people's clothing and in the well-dressed appearance of the community. Goods into which this material enters, or goods in which the warp is made of cotton, have not the enduring quality of the fabrics woven by our ancestors. President Eliot, of Harvard University, in a recent magazine contribution, says: "The Hessian country girl proudly wears her grandmother's woolen petticoats, and they are as good and as handsome as sixty years ago. A Scotch shepherd's all-wool plaid withstands the wind and rain for a lifetime"; and he adds a eulogy of the old Swiss porter's overcoat, which had kept him warm and dry for twenty-five years. In sharp contrast with these examples the learned college president speaks contemptuously of the "all-cotton" clothing of an American rural community that costs about ten dollars a suit, fades promptly, and wears out at the slightest provocation. If President Eliot desired his readers to infer that the farmers and peasants of the foreign countries which he names are better clothed than our own farmer classes, he unconsciously permitted himself too broad a generalization from the interesting and isolated instances which he cites. The machine-made cloths of this day and generation do not last a lifetime, or sixty years, or even twenty-five years, either in the United States or in Europe. The fabrics which so excited his admiration were the homespun products of hand manufacture. It is true that they had great endurance, and this quality they secured at the sacrifice of lightness and compactness. Heavy cloths of the homespun characteristics are not now made by machinery, because the people prefer lighter fabrics, even though they wear out quickly. They are able to gratify their preference because the evolution has reduced the cost of everything in the nature of wearing apparel to a degree only less striking than the increased productive capacity. It is equally difficult to express this gain in figures. But it is indicated by the fact that the farmer's wife can afford to abandon the spinning-wheel and loom and purchase the finished product of the fleece which she sends to market rather than to transform it herself into the long-lived goods which President Eliot so greatly admires.

How vaguely do the people realize the thousand-and-one comforts and conveniences and economies which have been brought into every household by the cheapening of fabrics of almost infinite variety of form and utility which the woolen manufacture has taken on! There is now no phase or form of want, of garment, of decoration, or of household economy, which can not be gratified at a reasonable cost.

The variety of the fabrics into which wool is now converted is one of the most striking features of the evolution. The carpets on our floors, the blankets that cover both our horses and ourselves, the reps and plushes that make the most durable and elegant coverings for household furniture, railroad cars, etc., the curtains that shade our windows and form the drapery of our doors and parlors, the stockings on our feet and the mittens on our hands, the knitted underwear that guards us from *la grippe*, the dresses in which our wives and mothers do their shopping, the clothes that we wear, the overcoatings and even the overshoes necessitated by our inclement winters, the bunting that we display on the house-tops on the national holidays—everywhere we utilize wool, and the more of the wool and the less of cotton, silk, linen, or other fibers used in all these ways, the warmer, the healthier, the more endurable, the more satisfactory is the result.

It would be interesting, had we not already far outstripped the bounds of a magazine article, to follow the manufacture into these subordinate branches, which are more numerous than in any other industry, and several of which, particularly the manufacture of carpets and of knit goods, present unique phases of development which have not even been hinted at in these pages. Enough has been said to show that the ancient myth of the golden fleece was prophetic of an industry which has added fabulous wealth to the world, and which will continue to supply increasing employment to labor and increasing employment to capital through all time to come.

HYPOCRISY AS A SOCIAL DEBASER.

BY DR. R. W. CONANT.

IT is difficult to decide whether the author of Hypocrisy as a Social Elevator is to be taken seriously. That a thoughtful and conscientious man who knows the meaning of hypocrisy could seriously advocate a doctrine so Machiavellian is the worst horn of a dilemma, and it seems more likely that he is simply trying to " raise a breeze." Indeed, this would be rather implied by his final statement, that he " calmly awaits the vehement chorus of dissent from this proposition."

Hypocrisy is, indeed, an indisputable fact, ancient as Adam and Cain and world-wide; but any claim that this detestable tendency of human nature is a social elevator requires a reply, if only because some persons rather weak on their moral and intellectual pins, particularly among the young, might take these sophistries seriously, to their own great loss and detriment.

In the first place, our advocate of hypocrisy seems unaware of the meaning of the word. It is from the Greek, " to question and answer," as actors on the stage; hence, to play a part, and especially to pretend to be better than one is in virtue or religion. What has this in common with the abstinence which Hamlet recommends to his mother in the extract which Mr. McElroy quotes? Nothing. Abstinence tends toward virtue, hypocrisy toward vice. But this is a minor matter, since Hamlet is scarcely a safe social guide.

A like confusion of ideas arises when he quotes these words, which he appears to fancy contain an element of hypocrisy:

> ". . . rise to higher things,
> With their dead selves as stepping-stones."

Tennyson's arrangement is better, but that is an error in taste. It is a more serious error to confound hypocrisy with the grandest attribute of man, the power to set his feet on his dead sins and rise toward the Throne. Not so hypocrisy. It hugs its sin in secret and sneaks toward hell. Better any day the bold sinner than the hypocrite.

Congratulations are in order for the Pharisees. They have at last found an apologist, perhaps an admirer; rather late, to be sure, but better late than never. It seems that "they were powerful promoters of the ethical development of the Jews," etc. There must be a big mistake somewhere, for it was said of them by one who surely had better opportunities for observing and knowing the Pharisees than Mr. McElroy, "O generation of vipers, who hath warned you to flee from the wrath to come?" "Woe unto you, scribes and Pharisees, hypocrites! for ye devour widows' houses, and for a pretense make long prayer; therefore ye shall receive the greater damnation." Rather a harsh way to address "powerful promoters of ethical development"!

But the excellence of the Pharisees is hardly a subject for serious consideration, and we hasten on to those portions of the argument which have some plausibility, viz., the cases of patriotism, women, and religion. The key-note of this hymn to hypocrisy is struck in the remark on the second page, "No man is worse by simulating goodness." This may sound finely epigrammatic, but unfortunately there is not a word of truth in it. Any one is *always* worse by simulating goodness, for that means assuming the appearance of it without the reality. Not only is he no more virtuous than before, but his vice has acquired an additional sneaking quality, which makes the man more contemptible *per se*, and infinitely more dangerous to the community. Imitation is the tribute which vice pays to virtue, doubtless, but the vice is none the less vicious.

In the case of patriotism it is doubtless true that exaggerated statements of the virtues and greatness of the past do little harm and often good, but it is rather far-fetched to endeavor to class such exaggerations as hypocrisy. The hypocrite is not anxious to exalt others, but himself; even if, in exalting himself, he pulls down others. But, waiving this confusion of terms, does any one suppose that myth is more elevating to a people than sober historical fact? If it were true, we had better find some way of suppressing future Grotes, Bancrofts, and Motleys.

As to the elevation of women, it might seem at first blush that Mr. McElroy was hardly serious in his theory that the young woman who asked her mother if she should "wash for a high-neck or low-neck dress" might in time, by the practice of such hypocrisy, rise to the virtue of a full-length bath! But seriously, is there any one who can regard such dirty hypocrisy as "a social elevator"? "He that is filthy let him be filthy still."

"Nothing aided the elevation of women so much as the arrant hypocrisy which took the form of mediæval gallantry. . . . At first hollow and specious to the last degree—thinly varnishing a bestiality so low that it was scarcely above that of a bull seal," etc. Here our apologist makes a point worthy of consideration. It can not be denied that gallantry, even exaggerated and underlaid by bestiality, is far better than boorishness; but to say that it is a social elevator involves a fallacy, very prevalent, to be sure, but none the less a fallacy—viz., the idea that fine manners make fine people. It is generally supposed, and sometimes preached, that manners, culture, education, music, what not, elevate society. Here lies the essential fallacy of this whole article and of all similar screeds—a confounding of *post hoc* with *propter hoc*; a putting of the cart before the horse. What is it to "elevate society"? To impart expertness in playing the piano, in making bright repartees, giving and attending dinners elegantly, dancing gracefully, or even being conversant with the latest poetry and science? These are not the elevators of society, but its ornaments. The flower can not elevate the stalk. Society is elevated just so far as it lifts its face toward Mount Sinai, and no more. The ten commandments are worth more as "elevators" than all the patent contrivances which the unregenerate mind of man can conceive.

Page after page of history gives the lie to such a theory. When were manners most elegant, wit most polished, culture most a fine art? In the palaces of Italy in the middle ages, in the courts of Louis the Grand and Foolish, in the halls of Henry and Charles; and where and when was society most rotten! No. it is a great mistake to suppose that fine manners *per se* elevate either men or women; nor have they any moral value except so far as they are the outgrowth and sign of a true respect and consideration, the ornaments of a society which loves truth and purity and justice.

But Mr. McElroy is particularly unhappy in choosing religious hypocrisy as an illustration of his theory. Nowhere have the effects of this most despicable trait of human nature been more evident and harmful; it has ever been the dry-rot of religion, eating out all that was best and sweetest. He appears to be quite favorably impressed with the way "the pagans were chased into the bosom of the Church with blade and brand." Surely he has read Lecky's History of European Morals, and knows that this same Church, so zealous for the conversion of pagans, had plenty of austere dignitaries whose children ran up into the hundreds, until like Joseph's corn they left off numbering. Verily, she was a precious hypocrite, with her indulgences in one hand and her dripping sword and fagot in the other, but hardly a happy example of a "social elevator." It has been generally admitted, at least by Protestants, that the moral and religious pall which overhung Europe during the dark ages was due to nothing so much as to the foul vapors given forth from that pit of corruption and hypocrisy which is now offered us as a "social elevator."

But perhaps our friend has a squint toward Rome, and may take exception to this scoring of the mediæval Church. Unfortunately, however, the same criticism holds of the Protestant Church of to-day, though of course to a far less degree. Hypocrisy is the cancer of every *prosperous* religion, and is to-day eating out its heart. The so-called orthodox Church is losing its hold on the masses, and why? Because it pretends to believe what it does not believe; because it persists in averting its face toward the twilight dimness of the past, instead of looking onward and upward toward the morning light.

But what is true of religion is universally true, that hypocrisy is a curse. It is one of the foul blots on all progress, and there is no health in it. The fact that it accompanies progress makes it no more a social elevator than misery and sin, which also flourish under progress. To every soul is presented this choice: "Here, O soul, is thy mask of flesh; behind it thou mayst work what thou wilt without fear of detection; behind it thou mayst think pure thoughts and noble aspirations, or thou mayst wallow in filth and plot murder and theft, and none suspect thee if only thou be an expert hypocrite." What a sensation there would be if by a fiat of Omnipotence this earth-mask might be stripped off now, in this year of grace 1891, and each trembling soul be exposed naked to the light, even as it shall in that great day! What a hunting of holes and hiding of heads—some carried so very high! What an *exposé* of dark closets and skeletons, and almost forgotten cesspools and underground ways; and what a dividing of sheep from goats when all the masks of hypocrisy were torn away! No more secret eating of sweet, stolen fruit; no more safe and secret hatings and backbitings and plottings; for wrong-doing and evil-speaking would rebound with the terrific force of a boomerang. Society would necessarily divide at once into two general classes: on the one hand the decent, the industrious, and the patriotic, those who had not seared their souls with sin, and who preferred good to evil; on the other, those who were unable to abandon their evil ways even under the penalty of publicity, and who would be left to herd by themselves and prey upon one another. Thus would heaven and hell be set up already on the earth. For the world is what man makes it.

And herein is seen the solution of that great mystery of the union of soul and body, apparently so incongruous, so hurtful. In no other way could the soul be forced to make choice between good and evil, and at the same time be left free and independent in its choice behind an impenetrable mask—two essentials for the formation of character. What shall be the shame and anguish of that soul which has abused this great opportunity, which has chosen to debase itself, in that great day when hypocrisy shall naught avail, when we shall see as we are seen and know as we are known! Now, wheat and tares grow together, and tares imagine themselves as good as wheat; for falleth not the rain on the just and on the unjust? But in the great winnowing-day tares shall learn that they are tares and trash. The remorse of the inebriate or opium fiend is the punishment of him who has wrecked his body merely; what shall be the remorse of him who discovers too late that he has wrecked his soul, and forever! That will be eternal punishment.

THE PRACTICAL OUTCOME OF SCIENCE.

By W. H. SMITH, M. D., Ph. D.

THE present is an age of scientific research, and in this is found the characteristic feature of the existing civilization. The ancients were our equals, if not superiors, in literature, but no nation of antiquity could for one moment compare with us in scientific achievements. In this respect ours differs from all the ages of the past. The laws of Nature have been investigated, discoveries made, and in a multiplicity of ways her forces employed to do the bidding of man.

Passing by the more familiar results of such researches applied in the form of inventions on every hand to some not so patent, it may be remarked that science has accomplished and is accomplishing the difficult task of prolonging the period of human life. This comes through the study of physiology, sanitation, and medicine, the result of which has been, as shown by Dr. Jarvis, in a report some years ago to the Massachusetts Board of Health, that the average longevity, which at Geneva, in the time of the Reformation, was 21·21 years, between 1814 and 1833 had increased to 40·68, and that as many people would live to seventy as reached forty three hundred years ago. The records of annuities on life show the same fact, proving, strange as it may appear, that within the last three centuries the average period of human existence has nearly doubled.*

While those cognizant of such facts realize the benefits resulting from the applications of science, we sometimes hear it urged that such things are effected by the work of practical men, and that the theorists are useless. A more absurd and misleading idea was never expressed in words, and yet it is taken up and believed by people who never stop to question its truthfulness. In this respect it stands on a par with many an adage that passes current to-day. What, for instance, could be more fallacious than that "Contentment is better than riches," "Murder will always out," or "Brave men are never cruel," when history furnishes the records of Marius, Sulla, Haynau, and Napoleon, men whose courage was never doubted, but who were guilty of acts of cruelty that would disgrace any age? Absurd and untruthful as are these sayings, they are no more so than the statement that any class of men studying science can be set down as theorists who are of no benefit to humanity.

This can be made more apparent by the consideration of a few incidents in the lives of great men. For instance, John Hunter spent a large portion of his time in acquiring knowledge of anatomical facts which were regarded as useless by his so-called practical associates. He was a man who believed that no knowledge was unworthy of attention, and consequently dug deep into the foundations of his favorite science. By such studies he learned how the arteries changed, and that, when the main trunk was obstructed, the collateral branches enlarged sufficiently to carry on the circulation. At first this knowledge did not admit of any practical application. Finally, a patient came to him with an aneurism upon a branch artery. Hunter was thus given and embraced the opportunity of demonstrating the practicalness of his apparently visionary study, inasmuch as he at once boldly tied the main artery, which, up to that time, no surgeon had ever dared to do. The result was that the patient's life was saved, and a new and valuable operation introduced into the science of surgery.

Linnæus, more than a century ago, was spending his time in the visionary pursuit of bug-hunting, when the Swedish Govern-

* Quoted from Draper's Conflict between Religion and Science.

ment became alarmed at the fearful destruction of ship timber in its dock-yards by a minute boring beetle, and applied to him for a remedy. He replied that the beetle which laid the eggs only appeared in the month of May, and that by submerging the timber during that period it could be protected from its ravages. The Government did so, and thus not only saved its timber at an insignificant expense, but also brought the derided bug-hunter into respect, as one who had demonstrated the practical utility of his apparently visionary study.

Researches upon the properties of laughing-gas and ether and investigations relating to the peculiarities of infusorial life also exhibit knowledge which at first appeared absolutely worthless, but was afterward found to be exceedingly practical. Students originally took ether for fun, and laughing-gas fell to the level of a wonder exhibited by itinerant lecturers; yet out of that knowledge was destined to come our modern discovery of anæsthesia, by which surgical operations may be performed without pain and without the knowledge of the sufferer. In like manner the researches upon the infusoria, from the time of Leuwenhoek to Ehrenberg, had apparently no practical value, yet from their discoveries have been developed a truer form of one of the most important practical doctrines of modern chemistry, a modification of the practice of medicine, a revolution of the science of surgery, an application of new and more correct ideas in matters pertaining to agriculture; and, combined with all this, remains the probability that their power for usefulness is not yet exhausted.

For the sake of illustrating the difference between the practical man and theorist, let us suppose two persons to visit the northern peninsula of Michigan seeking for iron. The one runs along blindly, takes up with every good show, and mines. The result is, he either makes a happy strike by mere accident, or spends thousands of dollars in useless search. The other has studied the laws of electricity, and knows that certain ores of iron are magnetic. He understands also that these ores will exert their influence through any amount of superincumbent earth. Consequently he provides himself with a dipping-needle and compass, and by the operation of these tells where a bed is located, its approximate depth, and probable amount of material. To prevent being deceived by the magnetic schists in that region, by means of his dipping-needle and compass he traces up the bed until he finds an outcrop. Thus have been located, at little expense, many of the mining regions of that locality. What an achievement is this, and how much better than the blind guesses of the so-called practical man!

The history of that wonderful piece of mechanism, the steam-engine, furnishes another illustration of a different character. In

150 B. C., Hero of Alexandria invented a little instrument called an eolipile, which was driven by the agency of steam. To all appearances it was, and must ever remain, a useless thing; and it was not until the latter half of the eighteenth century that this peculiar contrivance, after having passed through the hands of De Gary, Porta, De Caus, Guericke, Savary, Papin, Newcomen, Smeaton, and others, was transformed, by the inventive genius of Watt, into a low-pressure engine. The history of this and other inventions shows three classes of men to have wrought upon them: First, there were the investigators, who were content with only discovering the great laws and truths of Nature. Then there were the teachers or historians, whose life-work was to treasure and disseminate the truths obtained. As the virgins in the temple of Vesta in ancient Rome kept the sacred fires burning, and would not permit them to go out, so these men preserved the knowledge thus obtained until the third class, known as the inventors, appeared and made the application.

How many, while admiring the objects attained by this third class, have ever given a passing thought to the labors of the two others, without which the last could never have accomplished such magnificent results? But are not the investigators of Nature's laws as worthy of honor and as useful to humanity as are the inventors? Shall we compare Newton with the man who first made a suction-pump? Galileo, the discoverer of the properties of the pendulum, with the manufacturer of a wooden clock? Archimedes, the investigator into the buoyancy of liquids, with the person who constructed the first dug-out? Certainly not! The men who investigate the great truths of Nature, and the teachers who disseminate those truths, and thus make invention possible, are as true benefactors to humanity as are the inventors, though, unfortunately, this latter class too often receive all the credit.

In this connection we may also see that no knowledge is useless. The discoveries which at first seemed only ornamental are frequently the forerunners of the most magnificent results. A little plant peeps through the earth, buds, and throws out its leaves, a thing pleasing to the eye. Presently it blossoms, the flowers ripen, and the branches hang with luscious fruit. In like manner many of the discoveries of the past, in their own day and age apparently worthless, have in a subsequent generation been found to be fraught with the greatest benefit to humanity. They began as things curious and pleasing only to the lover of Nature, but ripened into results of surpassing grandeur. The knowledge which at one time seemed useless, at another has been found exceedingly serviceable; and, since this has been true in the past, shall it not also be true in the future? If it took nineteen hundred years from Hero's time until a Watt appeared to invent a steam-engine, shall any one deny the discoveries of to-day an equal chance? If the slight and apparently useless knowledge of the ancients in regard to electricity has been growing larger and larger until it culminates in our magnificent system of telegraphy and telephony, who dare predict a limit to the utility of any knowledge at present existing, however insignificant it may now appear?

Thus far we have been considering science in its bearing upon the physical wants of our race. However, man has a threefold nature—physical, intellectual, and moral; and, while science has been ameliorating the first, it has had an important influence upon the others. It is a great truth, in regard to all our powers, that they become stronger as we use them. Thus the blacksmith's arm grows sinewy by wielding the hammer. Even so it is with our mental powers. They are impaired by idleness and strengthened by exertion; and, in the "struggle for existence" or effort to attain the mastery over Nature, our intellectual faculties are brought into lively exercise and are accordingly strengthened.

In these days people are often asking which is the better education, the classical or the scientific; but, without attempting to consider that question, two facts may be observed: First, that language being the work of man, in its study the student can rise no higher than the source; and that Nature being the product of an omnipotent, omniscient, and omnipresent God, its study must lead a person

"Through Nature up to Nature's God."

The second fact is, that without scientific invention classical education would be impossible. Suppose the modern printing-presses and paper-mills were swept out of existence, how rapidly would linguistic study come to an end! The fact is, that scientific researches in a thousand and one ways have made linguistic study possible, and lifted humanity from barbarism to civilization.

It would be pleasing in this connection to note how the various intellectual faculties are improved by the study of the sciences. Memory, abstraction, generalization, reason, and, in short, all our powers can be thus developed. However attractive the topic, the space allotted to an essay of this kind will not allow dwelling upon the utility of scientific pursuits as a means of mental discipline, and they are passed by with the simple remark that the study of Nature, while beneficial to all our faculties, is peculiarly adapted to the development of our powers of observation. For this purpose there was no provision made in the old style of education; and how important it was that some training should be given in this direction must be patent to every one.

The Russian proverb says of the non-observant man, "He goes through the forest and sees no fire-wood"; and Dr. Johnson once declared that "some men would learn more in Hampstead stage than others in the tour of Europe"; or, to take an illustration: In a cathedral at Pisa swung a chandelier. Thousands had passed in and out in an unthinking, heedless manner before Galileo's day, but when the young Florentine philosopher looked toward that ceiling, that chandelier, as a type of the pendulum, took on a new oscillation, and its vibrations extended farther and farther, until they reached the very center of the earth, and again swung outward toward other worlds, to return, bringing tidings of the gravitation that holds sway on those celestial orbs. In like manner a humble stone-mason at Cromarty, Scotland, saw on the rock some peculiar forms. He examined them carefully, and deciphered from these hieroglyphics the record of the "Old Red Sandstone," and from that time onward the name of Hugh Miller has been known in almost ever hamlet of civilized earth. The life of that illustrious Frenchman, Baron Cuvier, furnishes another and excellent illustration of the same thing. In the plaster-quarries of Montmartre, just without the environs of Paris, were lying scattered here and there a lot of animal remains. Thousands and doubtless millions of people had passed that way, and seen in them only so many old bones. Not so when Cuvier looked. The time had come for the arcana to be opened, and like the dry bones in the prophet's vision they became alive again and began to speak; and, wherever geology is studied, there the voice is heard chanting pæans of praise to the immortal Frenchman. His was not the record of a man who waded through seas of slaughter to write his name

"Among the few, the immortal ones,
That were not born to die."

Yet he has written it on an equally enduring tablet; he has writsen it on the history of geological progress, where it will endure *per secula seculorum.*

Science has also turned her attention to legal pursuits, and made her voice heard in courts of justice. Nearly every one doubtless is familiar with cases of men who have been arrested, charged with murder, and the blood found upon their garments examined. It is also probably known that there is some difference of opinion as to the degree of certainty with which human blood can be distinguished from that of an animal. This difference seems to be, in part at least, the result of the different methods pursued by the various investigators. Many persons suppose that the corpuscles are the only things to be examined. These are globular in shape and of about the same form for nearly all the mammalia. They, however, show a difference in size, and from this difference may be told approximately the animal from which they have been derived. There is another and equally valuable method of distinction, which consists in breaking up the corpuscles. By means of a little acetic or sulphuric acid this may be accomplished, and then on slowly evaporating the solution we get crystals characteristic of the animal to which the blood belonged. By combining these two methods blood can be identified, not with absolute certainty, but with a high degree of probability.

However, probability is not enough. In a question where a man's life is at stake something more is demanded. Not probability merely but absolute certainty alone can satisfy the people. This in many cases we have. In 1852, in Essex, England, a man was tried for the murder of a woman. She had been found dead in her bed, with her throat cut from ear to ear. Among the prisoner's possessions was found a razor clotted with blood, and in the blood were detected two or three short cotton fibers. Taken and examined microscopically and compared with the clothing of the woman, it was found that in cutting her throat the assassin had cut through the strings of her night-cap, and these minute fibers of that remained as the silent witnesses of his guilt.

Sometimes mud or dirt adherent to clothes connects a person with crime, or a hair sticking under the nail of a boot may by comparison show that its possessor has trampled upon the head of the deceased; or, as in a case at Hull, England, the *Diatomaceæ* adhering to a man's shoes proved that he had been at the place where the murder had been committed.

Such are some of the ways in which the microscope aids us in ferreting out the assassin. It has, however, a wider application. Some years ago Ehrenberg, that old prince of microscopists, was employed by the Prussian Government to investigate a case of smuggling. A cask had been opened, valuables extracted, and the cask repacked, and shipped onward to its destination. The only clew to the criminals was that the unpacking must have been done at some of the custom-houses through which the goods passed. To all appearance, the microscope had a hopeless task. But not so. Ehrenberg took some of the sand that had been used in the repacking, placed it under his microscope, looked through his magic tube, and behold, there on the stand lay a peculiar specimen of *Foraminifera* That animal was found at only one place in the known world, and told at just what point the crime had been committed.

The history of England furnishes another illustration of the use of the microscope as a detecter of crime. A few years since the people were very much troubled about adulterations. Not only the tea and coffee they drank, but the food they ate, their medicines, and even their clothing were mixed up with foreign ingredients. In some cases this was carried to such an extent as to be simply diabolical. Wisely and well did the Government act.

Selecting one of the best scientists in the kingdom, they bade him investigate and prepare a remedy. The result was published in that book, Hassall's Adulterations Detected, a work that ought to make its author immortal. He there shows how all bodies differ in the minute structure of their granules, and renders it as easy to tell the genuine article from its adulterations as to tell apples from potatoes.

Some years ago a trial at Salem, N. Y., illustrated the value of science in questions of testimony. A man named Thomas Page, to gain possession of certain property, had forged a conveyance. The instrument purported to have been written in 1827, and was on paper colored blue with ultramarine. It was conclusively shown that ultramarine was not discovered until 1828, and not used in the manufacture of paper prior to 1841. By showing also that the paper was made on a Fourdrinier weaving-machine and by the calendering process, scientific and other evidence proved that it was probably not manufactured before 1845, and certainly could not have been in existence in 1827. The result was the overthrow of Page's suit, followed by his own prosecution, conviction, and sentence for forgery.

There was a time in the past history of the earth when, if a murderer could secretly place poison in the food of his victim, he might hope to accomplish his heinous purpose without fear of detection. Not so to-day. Chemical and microscopical analyses are applied to the stomach of the deceased, and with the symptoms reveal, not approximately, but with perfect and absolute precision, the cause of death.

But why stop to mention single instances when the records of jurisprudence everywhere are full of cases where science has been applied to legal affairs? The judicial investigation of such crimes as poisoning, wounds, infanticide, abortion, rape, illegitimacy, to say nothing of the deeds caused by insanity, must ever receive a large amount of aid at the hands of medical science.

In these Science does not always appear as an avenging Nemesis, hunting down and punishing the guilty. She sometimes plays the *rôle* of the vindicator of the innocent. Dr. Lyons gives an account of a case in which a man was arrested and charged with murder. A hatchet, smeared with dried blood and hair, was found under his bed. Indignation ran high, and people were almost disposed to lynch him. He was, however, detained, and the blood-stains and hair subjected to microscopical examination, when they were found to be those of an animal which he had killed and had then carelessly thrown the hatchet under the bed.

Such are some of the practical benefits accruing to us from scientific research. With Briarean arms it has reached out and laid hold of every part of our civilization. Proteus-like it assumes a thousand shapes, but under every guise remains still the firm friend of the human race.

Nor have the triumphs of science been less in the moral than in the physical and intellectual world. When the curtain of antiquity rises upon our race we find its moral condition of the lowest and most degrading character. What, then, has raised man out of that condition? It may have been revealed religion; but, in my opinion, scientific progress, by introducing higher and grander ideas, had much to do with it. Whatever may have been the cause, we have certainly left forever the dark ages of our fathers' beliefs. If we find a woman troubled with nervous disorder, we no longer look about for the person who has bewitched her, and cast that person into the water to be drowned as innocent, or to float and be burned as guilty; but we simply treat the woman for hysteria. If a man falls down and goes into convulsive movements with foaming at the mouth, we are not accustomed to follow the example of the ancient Greeks and Romans, and say he is possessed with an evil spirit; but we give him bromide of potassium or some other remedy to cure his epilepsy. If a plague or pestilence break out and sweep away half a city, we do not place our reliance on sacrifices and supplications addressed to the deities to avert their anger; but we seek the cause of it in a lack of cleanliness and remove the filth. We have learned that these things may be punishments sent from God, yet they come mediately, not for a moral sin, but for violating one of the physical laws of our being. Science found mankind everywhere believing that each tree, bush, or dark recess was peopled by an evil demon; but by the glorious sunlight of the nineteenth century she has banished these shapes of darkness from off the civilized earth, and planted in the brain of the people that intelligence, greater than an angel with a flaming sword, which shall forever prevent their return.

And then the ideas in regard to God, derived from the study of Nature, how surpassingly grand! The old Hebrew seers may have taught that Jehovah was infinite in power and wisdom, filling immensity with his presence, and existing from everlasting to everlasting; but it remained for astronomy, geology, and microscopy to show the profound significance of such utterances. Nothing is more humiliating than the study of Nature, However viewed, she but reflects back upon us the infinite wisdom and glory of her great designer.

Such have been some of the achievements of modern Science. She has, as it were, made a palladium out of the bones of Pelops. She has, indeed, been a mother of plenty, scattering blessings everywhere with a liberal hand. As the gods in ancient times are fabled to have piled Pelion upon Ossa, and rolled upon the top the leafy Olympus, in their daring efforts to scale the heavens, so modern Science has raised mountain on mountain high in her effort to rise to the eternal source of truth. She may not have sent Abaris around the earth on an arrow, but with lightning-like swiftness she sends our messages from ocean to ocean and from continent to continent. Her votaries may at times have seemed to some narrow-minded persons about to hang a Nessus shirt upon humanity, but, when the garment came to be received and understood, it was found to be not only destitute of the hydra venom, but filled with the greatest blessings for our race. Thus has Science wrought, opening up Hesperian gardens with their golden fruit, and, while scattering physical, intellectual, and moral benefits on every hand, has impressed upon man the grand truth that

> "No pent-up Utica contracts his powers,
> But the whole boundless continent is ours."

DRESS AND ADORNMENT.

I. DEFORMATIONS.

By Prof. FREDERICK STARR.

FOR our course of lectures in anthropology this year we have selected a single subject: *Dress and Adornment.* This will be treated in four lectures upon the following topics: 1. Deformation. 2. Dress. 3. Ornament. 4. Religious dress. It is not claimed that the treatment is exhaustive; it is hoped, however, that it will be suggestive. Nor is it the lecturer's expectation that his audience will agree with him in all his views; he simply asks a fair consideration.

The question as to whether beauty is a something inherent in an object or a person, that appeals to a universal sentiment of mankind, is one that has been much debated. The metaphysician and the anthropologist are likely to answer the question differently. There is certainly no one ideal of personal beauty that appeals to all the world alike. The face most beautiful to us would be displeasing to a Hottentot. We may well look for a moment at some ethnic ideals of beauty. The negro admires blackness; Clapperton tells us that among certain Africans the white color of the skin, of which Europeans are so proud, excites only pity, astonishment, or terror; the Chinese dislike our noses, which they say are like the beaks of birds; the woman in Cochin-China sighs to be round like an apple; and the Hottentot women do not look with disfavor upon those enormous fatty outgrowths above the hips which to us appear frightful. So a certain woman of the Nile tribes told Sir Samuel Baker that Lady Baker should have had her four lower incisor teeth knocked out and her lower lip pierced for a quartz labret—"by that she would become very beautiful." Thus we see, while all tribes have some ideal of beauty, it is an ideal which varies infinitely, and which has grown up among the tribes independently. All desire to attain to the ideal after it has once been established; and Tylor tells us that for this reason Hottentot mothers manipulate the baby's nose to make it more snub, while Persian mothers try to make it aquiline. In many cases, as we shall see, simple manipulation is not enough, and more heroic measures are taken to produce the desired effect.

Looking over the whole field of ethnology, we find a wonderful variety of curious deformations, mutilations, and modifications which are considered beautiful. Of these we shall describe a considerable number, commenting upon some as we mention them, and then shall try to draw from them some general principles of importance. For convenience, we shall group all bodily changes made for the sake of increasing personal beauty into four groups: 1. Perforations and filings. 2. Bandagings. 3. Color decorations, etc. 4. Hair-dressing.

First, then, as to perforations and filings—or mutilations. Many parts of the body are mutilated, either in order to make them serve as carriers of ornaments, as direct improvement of personal beauty, or for some useful end. The lips easily lend themselves to such an operation, and pierced lips are found in South America, in Africa and in the extreme Northwest of North America. The custom of piercing the lips in the past was also widely spread. The standard example is, of course, the Botocudo of South America, whose name comes from the Portuguese word for a plug, referring to the ornament inserted in the opening. These people wear, in lips and in ears, great circular disks, sometimes of hard and heavy wood, weighing even a quarter of a pound. This lip-plug drags the lip down to a horizontal position. Flower quotes Dampier as saying, in 1681, of the Corn Islanders, off the Mosquito Coast: "They have a fashion to cut holes in the lips of the boys when they are young, close to the chin, which they keep open with little plugs till they are fourteen or fifteen years old. They then wear beards in them, made of turtle or tortoise shell. The little notch at the upper end they put in through the lip, where it remains between the lips and the teeth; the under part hangs down over their chin; this they commonly wear all day, and when they sleep they take it out. They have likewise holes bored in their ears, both men and women when young, and by constant stretching with great pegs they grow to be as big as milled five-shilling pieces. Herein they wear pieces of wood, cut very smooth and round, so that the ear seems to be all wood, with a little skin around it."

In ancient Mexico labrets were worn, and very pretty little ones made of black obsidian and finely polished are not uncommon. These are shaped like a stove-pipe hat, the brim being placed between the lip and the lower teeth, and the crown projecting from the middle of the chin. Such labrets, although usually of obsidian, are sometimes of jade, and were occasionally of large size. Curiously enough, this same style of lip-plug is found among the western Eskimos. Within a century the custom of piercing the lips for labrets was prevalent in Alaska and British Columbia. The ornaments were sometimes three inches long by one and a half wide, of an oval form, and hollowed into troughs above and below. In fact, it is said that the Ahts took out the labret and used it as a spoon in eating hot soups, etc. Among the Tlingits of Alaska the women only wore labrets. The girl's lip was pierced as she approached womanhood, and a very small peg inserted in the opening. This hole was enlarged by the insertion from time to time of ever larger labrets. Only women of great age and high position wore the largest ones. The practice is now falling into disuse, and large labrets are almost a thing of the past. Small pegs of silver are the customary form at present.

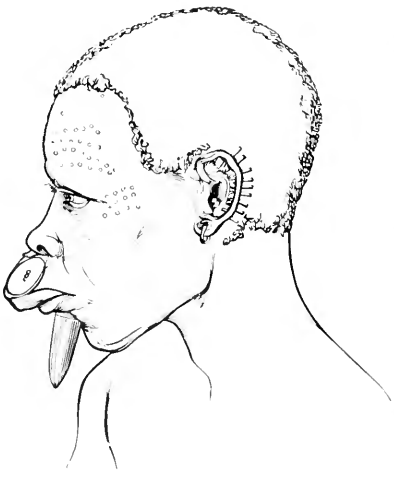


Fig. 1.—African wearing Lip Ornaments.

In Africa labretifery is quite as common, and varies from tribe to tribe. The Loobah wear a polished cone of quartz, some worn by men being even two inches in length. Mittoo women wear circular plates (Fig. 1); the Bongo wear plugs in both upper and lower lips, and seem to delight in the noise made by the ornaments striking together. Schweinfurth, from whom most of these African examples are taken, says these same Bongo women wear bits of straw in holes at the edges of the nostrils, a clamp at the corner of the mouth, and numerous little iron rings in their ears. "Some of the women have the body pierced in little less than a hundred places." Nuehr women wear in the upper lip a small ornament of iron wire covered with beads, which at a little distance looks like a cigarette in the mouth. Yet more curious is the *pelele* worn by the Manganya women (Fig. 2). It is a *ring*, made of metal, ivory, or bamboo, sometimes two inches in diameter, and worn in the upper lip. When the muscles of this lip contract, they throw the ring upward, so that the nose appears through the hole.

But the lips are not alone in the matter of being perforated for insertion of ornaments. The nose is often pierced, and this may be in two ways, either through the septum or through the walls of the nostrils. Captain Cook (quoted by Flower) says of the east Australians: "Their principal ornament is the bone which they thrust through the cartilage which divides the nostrils from each other. . . . As this bone is as thick as a man's finger and between five and six inches long, it reaches quite across the face, and so effectually stops up the nostrils that they are forced to keep the mouth wide open for breath, and snuffle so when they attempt to speak that they are scarcely intelligible to each other."

Fig. 2.—Manganya Woman wearing Pelele.

The ornaments put through the walls of the nose vary greatly. There may be but one perforation in each wall or there may be several. In New Zealand flowers, in New Guinea a boar's tusk, in the Solomon Islands a crab's claw, in New Britain thorns, set upright, are the objects thus worn. These are all original and primitive; after the natives come in contact with whites, these give place to metal buttons and rings. In the Sturgis Collection is a rather pretty nose-ornament from New Guinea. It is V-shaped, and the arms fit by stud-shanks, one into each wall of the nose. Nose-ornaments were known to the Jewess of the exile—Ezekiel, xvi, 12, "And I will put a jewel on thy nose"; and Isaiah, iii, 21, "The rings and nose-jewels." The *cheeks* are pierced by some Eskimos, who wear little round stud buttons in the holes. *Ears* are pierced the world over. A few cases must suffice. Schweinfurth says that Babucker women pierce the rim of the ears repeatedly and wear therein bits of straw an inch in length, having twenty such, perhaps, in each ear. This repeated piercing of the ear is common among barbarous people, and we have seen a woman of the Sac and Fox Indians who wore seven brass rings in one ear. Ears may be slit and stretched instead of pierced. They then hang in long loops. Catlin gives a picture of an Indian whose beauty had been increased in this way. The Anchorite Islander slits his ears (Fig. 3), while the Fijian often has them slit and stretched to such an extent that the two fists might be placed in the openings. Slit ears may be of practical use. The Kaffir carries his snuff-box in his ear-hole, and Captain Cook figures a Mangaia Islander who carried a large knife in his right ear.

"The Dyaks not only pull the lobes down to the shoulders, but also insert a number of brass rings around the rim. One man wore a large ring in each ear with smaller rings attached to it from which were pendent various articles. To one ear were thus attached two boar's tusks, an alligator's tooth, part of a hornbill's beak, three small brass rings, and two little bells." Among the Bongo we find the flesh of *the abdomen* slit for the insertion of sticks.

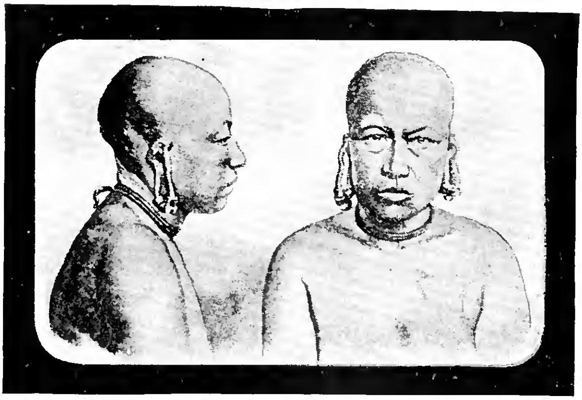


Fig. 3.—Anchorite Islanders with Slit Ears.

Akin to these perforations are the various forms of filing, boring, and breaking of teeth. The great districts for such deformations to-day are Australia, Malaysia, and Africa. In times gone by these were prevalent in Central America and Mexico, and Hamy describes a number of varieties. In Africa a score or more tribes file their teeth. With them it serves as a tribal mark. Thus the Batoka knock out the upper front incisors and let the lower ones grow up above the jaw. The Bongo, Kredy, Asango, and others chip and file them to various forms. The most elaborate designs, however, are found among the islands of the Indian Archipelago, where teeth are chipped, filed, engraved, bored and fitted with brass-headed brads, and dyed so that white patterns appear on a black ground (Fig. 4). In these cases the decorative idea is prominent, although—from the fact that Dyaks, Ryangs, and Batta differ in pattern and style—the custom retains, even here, some tribal significance. Notice the two purposes of the practice—(1) as tribal marks, (2) as a decoration. It should be also observed that many and curious reasons are assigned for the practice. The Batoka, for instance, say "they wish to resemble the cow, and not the zebra." Very generally these operations, like so many other mutilations, are performed as the individual approaches manhood or womanhood. In Australia it is markedly an initiatory practice, a recognition of the child becoming adult, a reception into the tribe.

The second group of bodily deformations is that of bandagings—various and widely spread. With these we may consider some freaks of unrestrained growth. In China and Siam the finger-nails are allowed to go uncut and attain great length. In China they are carefully oiled and kept in tubes; in Siam they are incased in silver tips. In China they also occur among religious ascetics. In all these the meaning is clear. The person with such nails does not and can not do ordinary manual labor. Hence they are a sign of nobility or of sanctity. The Marquesas Islander also wears his finger-nails long and pointed as a sign of rank. Of true bandaging—every one knows of the dwarfing of the Chinese woman's foot—the practice is confined to women, though not to women of the highest rank. Flower describes the physiological action and result of this: (*a*) Operation: "The four outer toes are bound under the sole in such a way as to leave the great toe only in a normal position and to bring the whole foot to a narrow point in front. (*b*) Results: The roots of the heel and toes are compressed downward and toward each other, shortening the foot and making a deep transverse fold in the middle of the sole." The subject of the operation, which is begun in childhood, is, of course, crippled for life. The bandaged foot becomes also an object that must not be seen, a disgrace; and yet the Chinaman calls it a "golden lily." In the Philippine Islands women bind their arms in order to gain the ideal of womanly beauty, a large fist. The results would even suit the present taste of Boston. The Wahamba, in East Africa, bind the legs of children, up to the knee, to make them calfless, "that they may run better"; while the Puris women, in South America, *develop* the calf excessively by bandages above and below, "for beauty."

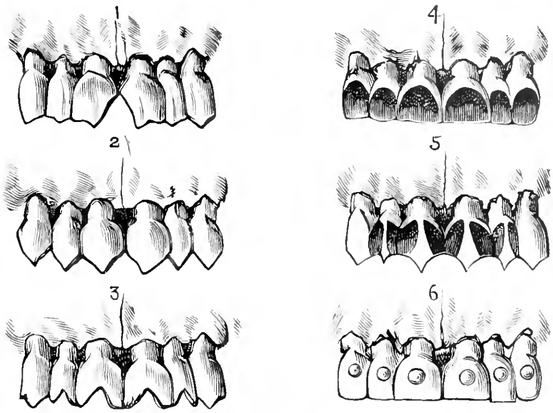
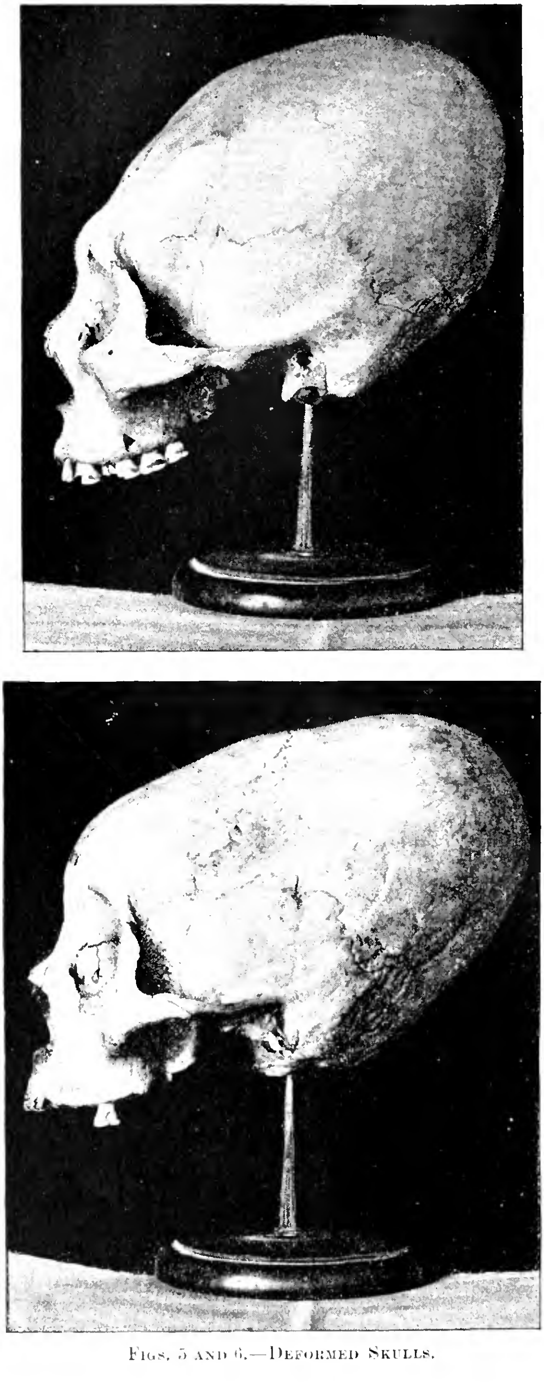


Fig. 4.—Tooth-filing—Malaysian Examples.

The most remarkable bandaging, however, is that of *the head*. Deformation of this kind has a wide range in time and space. Hippocrates speaks of it 400 B. C., and it still exists. And where has it *not* prevailed? It is known to have existed in the Caucasus, the Crimea, Hungary, Silesia, Belgium, France, Germany, Switzerland, Polynesia, China, and other parts of Asia. Nowhere, however, has it been more prevalent than on the western coast of both Americas. Of old races the Peruvians, Yucatanese, Mexicans, Caribs, Natchez, and some of the mound-building tribes deformed the head. In later days many tribes along the Northwest coast from Oregon to the Tlinkit territory have—or lately have had—the fashion. The method of applying the pressure varied. Sometimes a board was fastened firmly against the forehead, space being left between it and the back board of the baby-frame for the head to grow backward and upward to a wedge-form. Sometimes bands of cloth or bark were bound around the head so as to force the growth either upward or backward. All sorts of classifications of the various forms have been suggested. Three types, however, are particularly striking: (*a*) The "flat-head"—wedge-shaped; (*b*) the long cylindrical; (*c*) the "sugar-loaf." Ten different forms



Figs. 5 and 6.—Deformed Skulls.

have been described from Peru alone. All the important types may also be found within a very limited area surrounding Vancouver Island. Several questions arise in connection with this practice. Is the operation painful? Are the effects harmful? Is the result hereditable? "It might be supposed," says Mr. Kane, "that the operation would be attended with great suffering, but I never heard the infants crying or moaning, although I have seen their eyes seemingly start out of their sockets from the great pressure; but, on the contrary, when the thongs were loosened and the pads removed I have noticed them cry till they were replaced. From the apparent dullness of the children while under the pressure I should imagine that a state of torpor or insensibility is induced, and that the return to consciousness caused by its removal must be naturally followed by a sense of pain" (Fig. 7) (Flower). Are the effects of such alteration of the skull hurtful to the brain? Most authors agree that in savage or barbarous life little or no harmful result comes. This belief is founded upon two facts: (1) the individuals deformed appear quite as intelligent as their neighbors; (2) in such tribes as hold slaves the deformation exists only among the free population. Were the masters seriously affected by it in mind, they would ere now have become themselves the slaves. In civilization sad results follow. Dr. Foville proves that it causes headache, deafness, cerebral congestion, epilepsy, and worse brain troubles (Flower). As to heredity, Hippocrates claimed that the tendency to abnormal form of head *did* become hereditary; recent authors, as a rule, do not agree with him.

Fig. 7.—Flathead Child.

The third group of deformations or bodily alterations is color decoration, and under this we shall class body-painting, tattooing, and gashing.

Body-painting and face-painting are universal. The Gani wear no dress, but paint the whole body. Thus: "Two messengers were painted—their faces were white; the bodies were painted in two coats of purple and ashen-gray; the latter was scraped off so as to show the former in patterns below. Some men paint the body in horizontal stripes like the zebra, or in vertical stripes down the back, or with zigzags of a lighter color."

All our North American Indians paint, and the patterns vary with the individual, with the family, and with the occasion. From notes made upon Sacs and Foxes painted for the dance we will give but one or two cases. One man's face was painted black, except around the eyes and mouth, which were scarlet. Upon his forehead was a neat checkered pattern of yellow on the black background. Another's face was divided by a vertical line in two parts, one of which was a bright yellow, the other an equally bright green. Among the Fijians face-painting is carried to the extreme—e. g., "face all scarlet except nose, which is black;

FIG. 8.

face divided like a quartered heraldic shield and painted red and black or white; black face, white nose, scarlet ring about each eye, and a white crescent on forehead," etc.

And of our own ancestors, the Britons, Cæsar said: "All Britons, however, paint themselves with woad (*vitro*), which gives a dark-blue color, and by this means they appear terrible in battle; they wear long hair, and the whole body is shaved except the head and upper lip" (v, xiv).

And we may select a last example from Egypt. Loret says the ancient Egyptian women had blue hair, green eyelashes, painted teeth, and reddened cheeks. He says the modern Egyptian women are much the same; they tinge their hands with henna, and prolong the eyes by means of kohol; they stain the nails brown, and paint blue stars on the chin and forehead. "One hesitates a little about putting his hand into a hand—even very small—which extends itself to you painted a brick-red. One is a little timid about looking too long into eyes—even very tender—when the blue star between them makes you squint." Loret, however, got bravely over both his hesitation and his timidity, and thinks the fashion not altogether bad.

This body-painting is the most *individual* of all the modifications we are to consider. Each person in it exercises his own personal caprice or fancy. It is greatly esteemed. To get material the Huron Indian went twenty miles. Painting serves several purposes: (*a*) Tylor says the Andaman Islander plasters himself with lard and colored clay *as a protection* against mosquitoes and heat. (*b*) In most of the cases cited, painting is simply for display. (*c*) It often serves as a sign of mourning. (*d*) In the "woad" of the Briton and the "war-paint" of the Indian the purpose is to strike terror. Mougeolles suggests an origin for the practice that seems to us quite reasonable. Red is the commonest color used in body-painting; it was probably the earliest. The man who returned from battle covered with blood of hostile man or savage beast was a hero. Such a one might easily seek to constantly remind his neighbors of his success by replacing the real blood-stains by artificial ones as the original wore away. Humboldt says of the Orinocos that "*no paint* was a dishonor," but also that it was a chief's attribute, and that the chieftaincy was the reward of bravery. Herodotus says that "Thracian *chiefs* painted as a distinction. And, when in Rome, the victor ascended the Capitoline Hill painted with minium, there can be little doubt that he was simply using a very old symbol—of bloody victory.

Painting is temporary and needs frequent renewal. In many parts of the world we find color designs, elaborate, curious, sometimes beautiful, made permanent by tattooing. The pattern and the method vary greatly with locality. In some regions men only tattoo, in others only women, in others both sexes. Here it is confined to the nobles, there to the servile. In Abyssinia women chiefly tattoo. "The whole body is covered; even the gums are pricked blue. An old woman operator's tools were: a pot of blacking (charred herbs), a large iron pin, bits of hollow cane, and pieces of straw—these last for pencils. She marks out the design, pricks dots with the pin loaded with the dye, and goes over it repeatedly. To allay the subsequent irritation it is plastered over with a green poultice; the scab must not be picked off" (Wood).

Very different, and only interesting because of its novelty, is the method of tattoo found among some Eskimos. The pattern is sketched and threads are passed *under the skin*. These threads are loaded with pigment, and are drawn back and forth until the pigment is taken into the skin, when the threads are removed.

But the most remarkable examples are to be found in the Pacific islands. In the Marquesas Islands the patterns often represent animals: the head is covered with one design, the breast bears a shield, the arms and thighs are striped, the back is crossed, and each finger bears its own pattern. The tattoo is here applied to both sexes, though mainly to men. It is begun at nineteen or twenty years, and is rarely finished before forty. The instrument used is a small comb-chisel. The figure is drawn on the skin, the comb is dipped in ink of burnt cocoanut-shell and water, and driven by a mallet through the skin. Only a few square inches are tattooed at one time. The spot swells and becomes sore, with fever.

In New Zealand we find quite as remarkable a condition of things. The patterns here are composed of curves and spirals. The general design is conventional, and the lines of which it is composed bear special names. *These* may vary indefinitely in minor details. A difference of importance is found in the method of tattooing in New Zealand and that prevalent throughout *Polynesia.* Here the lines are *cut*, instead of being pricked in by points. "The patient lies on his back, with his head between the knees of the squat operator, who draws the outline in black pigment and slightly scratches it. The chisel, of tooth or a bird's bone, is then taken and the pattern *cut* through the skin. The operator dips the edge of the chisel constantly into the pigment and rubs it into the cut each few inches, using a little bunch of fiber. The cutting is done by hammering the chisel, not by a knife. The complete pattern takes two or three years. During the operation friends sing, to drown the groans of the subject" (Wood). In Japan the tattoo was formerly very common, but is now prohibited by law. Such designs as "a monster crab on the small of the back, a pretty cottage on the chest, or a scarlet fish between the shoulders," were common (Fig. 9). As to the origin and meaning of the tattoo we can scarcely err in regarding it the same as for painting. The victor returns stained with blood and

Fig. 9.—Japanese, showing Tattoo.

bearing an honorable wound. This is replaced by an artificial wound to show his prowess. We actually find *this* practice in Kaffirland, and the Tuski makes a permanent mark upon his face for each act of courage. The idea once originated, the arrangement of such scars in an ornamental fashion and the adoption of colors would gradually arise, and in time the whole matter would become simply ornamental, a sign of rank, or religiously symbolical.

Gashing is a most remarkable custom, best studied in Africa and Australia. In Africa, gashes cut upon the forehead, cheeks, breast, or elsewhere, serve two chief purposes: (1) as tribal marks; (2) as signs of prowess. The Yorubas have perpendicular scars from temples to chin; the Ijasha have a long parallelogram of cross-lines; the Maheés, three long oblique cuts on one cheek and a cross on the other; the Nyambanas, pimples or warts, the size of a pea, from the top of the forehead to the tip of the nose (Fig. 10). These gashes are usually made with a knife, and wood-ashes or some other irritating material is rubbed in, to cause a swelling scar.

FIG. 10.—NYAMBANA TRIBAL MARK.

To what an extent these cuttings are carried may be seen in the Bornu, where "twenty cuts on each side of the face, converging in corners of the mouth, from the angle of the lower jaw and the cheek-bones, while a single cut runs down the center of the forehead; six cuts are made on each arm; six more on the thighs; the same number on the legs; four on each breast; nine on each side above the hip-bones. These are made in infancy, and the children suffer not only from the pain of wounds but from the countless flies that settle on the *one hundred and three* cuts."

As a sign of war prowess, the gash of the Kaffir warrior, already mentioned, may be described. After an act of bravery, the priest cuts a deep gash in the hero's thigh. This heals blue and is a prized honor. Interesting examples of scars as tribal marks might be described from Australia. To realize the value of a tribal mark, think for a moment of the savage man's relation to the world outside. He is a very Ishmaelite. So long as he remains on his own tribal territory he is safe; when on the land of another tribe, his life is the legitimate prey of the first man he meets. To men in such social relations the tribal mark is the only safety at home; without it he would be slain unrecognized by his own tribesmen. There must have been a time when the old Hebrews knew all about this matter of tribe marks. By this custom only can we fully understand the story of Cain (Gen. iv, 14, 15), who fears to be sent from his own territory lest he be slain by the first stranger he meets, but is protected by the tribal mark of those among whom he is to wander being put upon him. "I shall be fugitive and vagabond in the earth, and it shall come to pass that every one that findeth me shall slay me. And the Lord said unto him, Therefore whosoever slayeth Cain, vengeance shall be taken on him sevenfold. And the Lord *set a mark upon Cain*, lest any one finding him should kill him." But in scarring, as in so many other cases, the original idea is often lost, and the mark becomes merely ornamental. This is particularly true among women. Among men it more frequently retains its tribal or religious significance.

Fig. 11.—Batoka Hair-dressing.

And last of the groups is *Hair-dressing*, which is wonderfully varied. Africa is again the best field for study. The Batoka works the hair into the form of a ring and then builds it up into a cone, piecing it out with the hair of beasts, and adorning it with red ochre (Fig. 11). The Kaffir, when he is no longer a boy, goes to a friend to have his hair dressed. "The friend takes an assagai, sharpens it carefully; takes gum, sinews, charcoal, and oil. He makes an oval ring of sinews half an inch thick, and fits it firmly over the head. He then weaves the hair into this, and fixes it with gum and charcoal. Oil and grease are applied until all shines. The head is then shaved, except the ring. This is variously useful—holds feathers firmly, carries snuff-spoons, etc.," in addition to its value as a distinction. Of one tribe it is said that they wear most exquisite helmets, formed of their own hair; these cost an infinity of care and trouble and time, and are resplendent with beads, ostrich-plumes, and metal crest. To attempt the barest outline of the diversity of hair-dressing, however, would take us too far. With two or three examples, outside the African area, we must stop. The Fijians are remarkably fond of grand coiffures. Williams tells us that "many chiefs have a special hair-dresser, to whom they sometimes devote several hours a day. Their heads of hair are frequently three feet in circumference—one was nearly five feet. They also dye their naturally black hair at times to white, flaxen, or red." A curious point may be mentioned in this connection.

Such head-decorations would be injured were one to lie down and rest his head upon the ground, so a special type of wooden pillow is used in Fiji. It is placed under the neck, and keeps the hair free of the ground. Similar pillows are found wherever such care is bestowed in hair-dressing—as in Africa and Japan to-day, and in Egypt thousands of years ago. The cases already given are ornamental simply, or indicative of rank; hair-dressing may, however, become a tribal or family mark. The Siamese tuft—"lotus bud"—is such a case, as are also the Chinese queue, and the curious styles of hair-dressing that distinguish *gentes* among our Indian tribes.

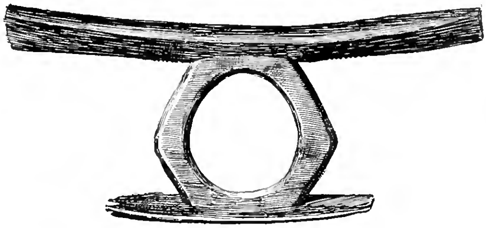


Fig. 12.—Fiji Pillow.

Here we have a *host* of curious customs before us. From them we may draw some general conclusions. Leaving for the present all the *religious* significance of these mutilations and deformations aside, we find—

First. These alterations are an actual gain or advantage in several ways: (*a*) as tribal marks; (*b*) family signs; (*c*) social distinctions.

Second. Whatever the actual original significance of deformations, they illustrate the action of two important *contrary* laws: (*a*) A law of strife for self-assertion or individualization; this really operates as the beginning of every one of these we have considered. The man who has *done something*, feels himself to be some one—desires to mark himself off from the rest visibly. (*b*) But the law of imitation leads to that which was at first an individualizing thing, becoming customary and fashionable.

Third. These deformations are all *beautiful* to those who practice them. Is it not evident that in all of them the idea and the ideal of beauty are subsequent—*not* antecedent and original?

PROFESSOR HUXLEY AND THE SWINE-MIRACLE.

By W. E. GLADSTONE.

THE controversy, in which this paper has to take its place, arose out of a statement, indeed a boast, as I understood it, by Prof. Huxley,* that the adepts in natural science were assailing the churches with weapons of precision, and that their opponents had only antiquated and worthless implements to employ in the business of defense. I took upon me to impeach at certain points the precision of the Professor's own weapons.† Upon one of those points, the miracle of the swine, as recorded in the Gospels, he had given us assumption instead of proof upon what he thinks the vital question, whether the keeping of the swine was an innocent and lawful occupation. He has now offered an elaborate attempt at proof that such was its character. The smallest indication of such an attempt in the original article would have sufficed entirely to alter the form of my observation, which would then have been what it will now be; not that he offers no argument, but that his argument is unsound from the beginning to the end.

Of that considerable portion of his article which is devoted to sneers, imputations, and lectures against myself, I shall take no notice whatever. The question of my guilt or innocence is too insignificant, and even the question whether Mr. Huxley does or does not always use weapons of precision might hardly warrant a prolongation of the warfare. But the personal action of our Lord is the basis of the Christian revelation, and to impugn it successfully in any point is to pierce the innermost heart of every Christian. No inquiry, therefore, can be too painstaking which helps to carry such a question to a conclusive issue.

I must, however, in passing, make the confession that I did not state with accuracy, as I ought to have done, the precise form of the accusation. I treated it as an imputation on the action of our Lord: he replies that it is an imputation on the narrative of three Evangelists respecting Him. The difference from his point of view is probably material, and I therefore regret that I overlooked it. From the standing ground of those who receive the

* Nineteenth Century, July, 1890, p. 22. [Popular Science Monthly, September, 1890, p. 619.]

† Impregnable Rock of Holy Scripture, p. 260.

Scriptures, it is not so considerable. That Christ, who is not only the object of imitation, love, and worship, but the very food and life of Christians, is the Christ of the Gospels. In a sense relative yet not untrue, they may almost be called "the brightness of His glory and the express image of His person."* If the Gospels are put on their trial as literary documents, and if a legitimate though mordant criticism can successfully impugn any portion of them, we can not complain, and must take our chance. But when their contents are summarily condemned and rejected on a charge of intrinsic unworthiness and immorality, upon no higher authority than that of the private judgment of this or that individual, then, and so long as we are dealing with a portion of the attested portraiture, an arraignment of them becomes, at least in my view, more hard to distinguish from an arraignment of Him whom they portray. Told, and told in detail, by all the three Synoptics, the miracle of the demoniac and the swine does not well bear severance from the staple of the biography. Nor, indeed, is it so severed by Mr. Huxley,† who frankly treats it as involving at large the authority of the Synoptic Gospels. In itself, it is undoubtedly of the utmost significance, on account of the questions which it raises. One of these is the large subject of demoniacal possession, on which I do not presume to enter. Another is whether our Saviour in answering the prayer of the evil spirits by "saying unto them, Go," became a co-operator in the destruction of the swine. This has been contested, but I pass by the contest, and for argument's sake at least admit the affirmative. Then there remains the further question; whether the beneficent ministry of our Lord on earth included in this instance the infliction of heavy injury upon certain individuals, the owners, or keepers and owners, of the swine, by the destruction of their property lawfully and innocently held?

Mr. Huxley observes that the Evangelists do not betray any consciousness of the moral and legal difficulties involved in the question. But if the Evangelists believed that our Lord was dealing in this case with Hebrews, or with persons bound by the law of Moses, then for them, believers in the Messiah, there were no legal or moral difficulties at all.

There are, indeed, those who have been content to rest the case on the absolute right of the Deity to deal at will with the property of the creatures whom he has made. "Of thine own have we given Thee!" Commentators are far from uniform.‡ But, as it appears to me, the question does not come before us quite in this shape. Apart from any such contention, it is no trivial in-

* Heb. i, 3. † Nineteenth Century, December 1890, p. 968.

‡ Consult Cornelius *a Lapide*, and his references to others, on Matt. viii, 28–34. Thomas Scott's commentary is worthy of notice.

quiry whether we have to record in this case the existence of an exception to the general character of our Lord's ministry, which was both beneficent and law-abiding. So far as regards the taking of animal life, the matter need not be discussed. It was life destined to be taken, taken by violence and probably with greater pain. It may have been, undoubtedly, the highest practical assertion of power, which is recorded by the Evangelists. But there is a remaining question, namely, whether this assertion of power was such as to involve serious injury to the proprietary rights of innocent persons. This is the character which Prof. Huxley stamps upon the narrative; justly, as he thinks, but, as I hold, in defiance of historical authority, and of the laws of rational and probable interpretation. I can not, however, but agree with him on two points which appear to be important: namely, first, that the excision on moral grounds of this narrative from the Synoptic Gospels affects their credit as a whole, and, secondly, that it is material to know whether the act recorded involved the infliction of a heavy penalty upon conduct in itself innocent.

The first question that arises in approaching this inquiry is, where did the miracle take place? And I do not well understand how Mr. Huxley, or his authorities, have so readily arrived at the conclusion that the very existence of any place named Gergesa is very questionable.* Origen was a learned man, of critical mind, and he resided for a large part of his life in Palestine, and traveled there only two centuries after the time of our Lord.† He tells us expressly these three things:

1. That there was an ancient city named Gergesa on the Lake of Tiberias.

2. That, bordering on the water, there was a precipitous descent, which it appears, or is proved (δείκνυται), that the swine descended.

3. That Gadara is indeed a city of Judæa, with very famous baths, but has no precipitous ground in the vicinity of water.‡

This statement from such a source, at such a date, appears to require a treatment much more careful than the dictum that the existence of Gergesa is "very questionable." I admit, however, my obligation under the circumstances to inquire also, and fully, into the case of Gadara.

Let me now summarily point out what I conceive to be the main sources of error, which, taken together, vitiate the entire argument of Prof. Huxley.

1. Throughout the paper he confounds together what I had

* Nineteenth Century, December, 1890, p. 972.

† See also McClellan's New Testament, on Matt. viii, 28, for the testimony of St. Jerome.

‡ Orig., Comment. in Joann., p. 145.

distinguished, namely, the city of Gadara and the vicinage attached to it, not as a mere *pomœrium*, but as a rural district.

2. He more fatally confounds the local civil government and its following, including, perhaps, the whole wealthy class and those attached to it, with the ethnical character of the general population.

3. His one item of direct evidence as to the Gentile character of the city refers only to the former and not to the latter.

4. He fatally confounds the question of political party with those of nationality and of religion, and assumes that those who took the side of Rome in the factions that prevailed could not be subject to the Mosaic law.

5. His examination of the text of Josephus is alike one-sided, inadequate, and erroneous.

6. Finally, he sets aside, on grounds not critical or historical, but purely subjective, the primary historical testimony on the subject, namely, that of the three Synoptic Evangelists, who write as contemporaries, and deal directly with the subject, neither of which is done by any other authority.

7. And he treats the entire question, in the narrowed form in which it arises upon secular testimony, as if it were capable of a solution so clear and summary as to warrant the use of the extremest weapons of controversy against those who presume to differ from him.

Our main question, then, is the lawfulness and innocence of the employment of the swineherds. The ethnical character of Gadara and of its district derives its interest from its relation to that main question. In my opinion, not formed without an attempt at full examination, there is no historical warrant for doubting that the swineherds were persons bound by the Mosaic law. In the opinion of Mr. Huxley,* "the proof that Gadara was, to all intents and purposes, a Gentile and not a Jewish city, is complete." And, again,† Gadara was, "for Josephus, just as much a Gentile city as Ptolemais." Utterly contesting these two propositions, I make two admissions: first, that one or more of the many and sparse references of Josephus may easily mislead a prepossessed and incomplete inquirer; and secondly, that in the territory of Gadara, and in various other parts of Palestine, it would be a mistake to look for a perfectly homogeneous population either Hebrew or Gentile.

Outside the text of Josephus, Prof. Huxley adduces but a single fact in support of his allegations concerning Gadara—the fact, namely, that its coinage was Gentile. But coinage is essentially, and is most of all in conquered a country, the work of the

* Nineteenth Century, p. 973.

† Ibid., p. 974.

governors, wholly apart from the governed. To say that the Gadarenes "adopted the Pompeian era on their coinage,"* out of gratitude, must almost be a jest. If Pompey re-annexed Gadara to the Syrian province,† it is most improbable that he should have altered its laws respecting religion. Mr. Huxley supposes this change was popular as a restoration of Roman authority. But, had he consulted the text of Josephus, he would have seen it was approved, because the cities were restored by him to the "Home Rule" of their own proper inhabitants.

I. THE REVOLTED JEWS.—Mr. Huxley comes nearer to the point when he touches the text of Josephus,‡ on which, indeed, apart from the Synoptic Evangelists, we have chiefly to depend. He deals with the passages found in the 18th chapter of Book II of the Judaic War. Now, these passages are most dangerous and seductive to those of his opinion, because, if severed from other passages, they would prove his point: on one condition, however, namely this, that we admit what is, indeed, his master fallacy, to be sound in logic and in fact.

He says # that the revolted Jews are stated by Josephus to have laid waste the villages of the Syrians, "and their neighboring cities, and after them Gadara and Hippos." He then cites from Section 5 the passage which states that Scythopolis, Askelon, Ptolemais, and Tyre slew or put in prison great numbers of Jews. "Those of Hippos and those of Gadara did the like; as did the remaining cities of Syria." And hereupon Prof. Huxley assumes that his case is proved: *causa finita est.*

And so, perhaps, it might be were we to adopt what I have termed his master fallacy. That master fallacy is his assumption as to the cleavage of the Palestinian communities. According to him, all that was anti-Roman was Jewish or Hebrew, and all that acted on the other side was Gentile. Where, as in Tyre or Ptolemais, the population generally is known to have been Gentile, this assumption would, in the absence of evidence to the contrary, be a fair one. Such, in Mr. Huxley's view, was the case of Gadara, where the Jews were only local immigrants, like the inhabitants of a Ghetto.‖ But this is just what he ought to prove; and it is not proved by showing either that those Jews who were in revolt attacked a part of the Gadarite population, or that the Gadarite population afterward did the like to some Jews among themselves. For the whole text of Josephus testifies that the Jews, as often happens in a case where foreign domination exists over a people of high nationalism, were sharply divided among themselves on the point of resistance. There were among them

* Nineteenth Century, p. 973.

† Josephus, de Bell. Jud., i, 7, 7.

‡ Nineteenth Century, p. 974.

Ibid. on Bell. Jud., ii, 18, 1.

‖ Nineteenth Century, p. 974.

Roman and anti-Roman factions; ardent spirits always disposed to rise, and spirits more sluggish and pacific, who were either indifferent or indisposed to run the risk. Further, the strife between these sometimes went to blood, and not unfrequently placed the same community on different sides at different times. This, undoubtedly, I have to prove. I will first illustrate it by various cases including even Jerusalem itself, and will afterward show that, if we wish to make sense and not nonsense out of Josephus, we must apply the same ideas to Gadara, which besides, in all likelihood, had some mixture of population, and classes possessed of wealth and influence, which were sure to take the Roman or anti-national side.

I must first, however, observe that Mr. Huxley has quoted the text of Josephus inaccurately. As he has cited it, the revolted Jews proceeded at Gadara and Hippos as they had done in the cities of Syria that he had previously mentioned. But what Josephus says * is that they devastated (wholesale as it were) these Syrian cities, and that then, proceeding against Gadara and Hippos (which meant territories and not mere cities), they burned some places, and reduced to submission (not the rest but) others; thus, pointing to those differences of local faction, class, or race, in the different neighborhoods, which Mr. Huxley overlooks.

Sepphoris, the chief city of Galilee, and the strongest, exhibits those anomalies of political position which belonged to a conquered, disturbed, and variously divided country. It was one of the five great Hebrew centers, which Gabinius chose to be the seats of Sanhedrims.† After the death of Herod, it was taken and destroyed by the Romans, and the population reduced to slavery. Subsequently it was repeopled. When Vespasian invaded Palestine, it asked and obtained from him a Roman garrison,‡ as it had also received Cestius Gallus with acclamations not long before.# Yet, nearly at the same period, and probably between these two occasions, when Josephus was engaged in preparing Galilee for defense, by fortifying at the proper points, he left Sepphoris to raise its own walls,‖ because while it was rich it was also zealous for the war. Later on, Sepphoris was required to give hostages to the Romans^ at the very time when it was exposed to the jealousy and hostility of the Jews. Thus the same city, according to local fluctuations, was the partisan to-day of one side, to-morrow of the other. A clear comprehension of this shifting character in the local facts is vitally necessary for a sound judgment on the case before us.

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* Bell. Jud., ii, 18, 5.

† Antiq. xiv, 5, 4; Bell. Jud., i, 8, 5.

‡ Ibid.

Ibid., ii, 18, 11.

‖ Ibid., ii., 20, 6.

^ Vita, c. 8.

Again, Gamala,* on the Sea of Tiberias, adhered at this time to Rome; a little later we find it one of the last and most obstinate strongholds of Judaism against Vespasian.† Further, Gabara, as I shall presently show, exhibited similar variations.

In truth, as Milman ‡ says, "every city was torn to pieces by little animosities; wherever the insurgents had time to breathe from the assaults of the Romans, they turned their swords against each other." It was in Jerusalem most of all that these bloody factions raged; they were exasperated by the arrival of strangers; the peace parties shed the blood of the warlike, and the war parties of the peaceful.# In truth, such had long been the condition of that city, that Vespasian wisely postponed the commencement of his operations for fear he should extinguish the local feuds, which, as he saw, were wasting the strength of the rebels, and should compel them to unite together.‖

It is, then, quite conceivable that when Josephus says the revolted Jews burned some places and subjugated or kept down others in Gadaris, he means to speak of places where the peace party, which might be Jewish or not Jewish, predominated; and when he says the Hippenes and the Gadarenes acted against the Jews, he probably means that the Jews of the war party were put down by antagonists averse to war, though of their own race, as much as, and even possibly more than, by Gentile portions of the population. This, I have said, is a conceivable opinion. But, in order to justify what I have said of the argument of Prof. Huxley, I must show that it is an opinion not only conceivable, but warranted, and even required, by a consideration of the whole evidence on the record. That is the best conclusion, which best meets all the points of the case. The conclusion reached by Prof. Huxley leaves Josephus in hopeless contradiction to himself.

For I shall now proceed to show that Gadara or Gadaris, first, was an important center of Jewish population, by which I mean population subject to the Mosaic law; secondly, was a recognized seat of Jewish military strength; and thirdly, according to Josephus himself, acknowledged the law of Moses as its local public law, and was bound to obey it.

II. THE ORDINANCE OF GABINIUS.—Mr. Huxley places great reliance on the "classical" work of Dr. Schürer,^ which treats of the history of the Jewish people in the time of our Lord. And certainly a high tribute to it is due from him, as it seems to have supplied nearly all his material for the history and character of Gadara; except, indeed, the exaggeration of the terms in which

* Vita, c. 11.

† Milman, Hist. Jews, ii, 280–4.

‡ Ibid., ii, 290.

Milman, Hist. Jews, ii, 315 *seqq.*

‖ Ibid., ii, 305.

^ Geschichte des jüdischen Volks im Zeitalter Jesu Christi, Leipzig, 1886–'90.

he describes them. It may, perhaps, be questioned whether a work, of which one half bears dates so recent as 1889 and 1890, can yet have fully earned the title of a classical work. I do not, however, presume to question its ability and research. On the other hand, without detracting from its general character, I can not presume it to be precise and conclusive upon every one of those complicated local histories of Palestinian towns, among which Gadara has to be reckoned. Nor can I help embracing the opinion that he is (in the case before us) overfond of giving the go-by to a difficulty by altering the text of his authority, so as to make it conform to the view he has adopted. No less than five times,* upon this very limited subject, does he accept or propose this method of proceeding. At the same time, he altogether passes by phrases, and even passages, of Josephus. which are of real, and, in one or more cases, even of capital importance.

Let the reader test what I have said, in the first place, by reference to the weighty statement of the Jewish historian as to the Sanhedrims of Gabinius.

Soon after the conquest by Pompey, who had himself given proof of his moderation and regard for the religion of a conquered people, Gabinius became administrator of the Roman power; and he divided Palestine into five regions, for the purpose of administering the Jewish law in each of them, through an assembly of elders termed Sanhedrim; possibly also with a view to the easier and more effective collection of the Roman tribute.

Of these regions, according to the text as it stands, one had Gadara for its center; the others being Jerusalem, Sepphoris, Jericho, and Amathus. The measure, and the name of Gadara, are mentioned in two separate passages. Here we have to all appearance a pretty flat contradiction to the theory that Gadara was a Greek or a Gentile city. Accordingly, says Mr. Huxley,† Schürer has "pointed out" that what Gabinius really did was to lodge one of these (the Sanhedrims) in Gazara, "far away on the other side of the Jordan." Under this facile phrase of "pointing out" is signified the deliberate alteration of the text, which inconveniently asserts not only in two separate passages, but in two separate works,‡ that the place selected was not Gazara but Gadara. Without doubt any theory can be established with ease, if we are free thus to bend the original text into conformity with its demands. In this instance that text contains, as we shall see, a specific statement, which, as Mr. Huxley must have found if he had referred to Josephus, made it manifestly impossible that he could have written Gazara in these two places.

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* Antiq., xiii, 13, 5 (Schürer, ii, 91); ibid., xiv, 5, 4; Bell. Judd., i, 8, 5; ibid., iii, 7, 1; Vita, c. 15.

† Ninteenth Century, p. 973.

‡ Antiq., xiv, 5, 4; Bell. Judd., i, 8, 5.

I confess that Dr. Schürer appears to me to have seriously misapprehended in some degree the spirit of this measure as well as the facts, when he says * that it involved the abolition of whatever residue of political independence had thus long remained to Palestine, because Hyrcanus was now deprived of his temporal and confined to his priestly power. If we examine the matter according to the reason of the case, it was probably a great gain to the population to have the Mosaic law administered at its own doors by its own local leaders rather than by a priest-king sitting at a distance in Jerusalem. If we test it by the general spirit of the policy of this proconsul, we are led to suppose it friendly, because with it there was combined the rebuilding of some cities which had been overthrown. If we follow the authority of Josephus, we are bound to take it as a measure altogether favorable to Jewish liberties; for he says, † "thus the Jews were liberated from dynastic rule, and remained under the government of their local heads" (ἐν ἀριστοκρατείᾳ διῆγον).

Since the text, as it stands, entirely overthrows the doctrine that Gadara was a Gentile city, the propounders of that theory can only meet their difficulty by altering it, although they must surely feel that the contradiction of two independent works is a remedy not daring only, but rather desperate.

But, independently of the confirmatory witness of a double text, Josephus can not have written Gazara, for, if he had done so, he would have committed the absurd error of contradicting himself in the very sentence in which he wrote it.

Gazara is not only "far on the other side of Jordan." We are dealing with the northeast of the country, and Gazara is in the extreme southwest. Josephus says expressly that Gabinius divided the country into five *equal* districts. Now the old kingdom of Judæa may be taken roughly as one third of Palestine. Samaria was probably excluded: even if it were not, the case is not greatly altered. For the emendation thus "pointed out" entirely overthrows the equality of the districts. It gives to Judæa three out of the five Sanhedrims, and, leaving Amathus for the country beyond Jordan, assigns to Sepphoris alone the Galilees and Decapolis, or a territory about as large as that given to the three southern centers conjointly.

It can hardly be necessary to observe that, besides this fatal objection, Gazara seems to be disqualified by its geographical remoteness near the southwestern border, and perhaps also by comparative historical insignificance.

The emendation, then, has to be committed *emendaturis ignibus* for self-contradiction; and the twice-repeated testimony of Josephus stands intact, showing that, shortly after the time of

* Gesch., i, 276.

† Antiq., xiv, 5, 4.

Pompey, Gadara was chosen for a purpose which obviously required, and which therefore establishes its being, a great center of Hebrew or Mosaic population.

III. MILITARY IMPORTANCE.—Having shown that Gadara was important as a center of population which was either Jewish in blood or governed by the Jewish law, I will next show that Gadara was also formidable as a seat of Jewish military power. The time came when Vespasian had to contemplate operations against Jerusalem. And now, says Josephus,* "it was necessary for him to subdue what remained unsubdued, and to leave nothing behind him which might prevent his prosecution of the siege."

Accordingly, he marched to the point of danger. This was Gadara, the strong metropolis of Peræa, which had once, against Jannæus, stood a siege of ten months. The rich, who were numerous there, escaping the notice of their opponents, had invited him. On the approach of Vespasian, the party disposed to war found itself (and no wonder) in a minority, and fled; but not till they had massacred Dolesus, the author of the invitation to the Roman general. In their absence, the people received Vespasian with acclamations. But they pulled down the walls of their own accord; and he then left with them a garrison of horse and foot to defend them against the return of the expelled party. Why were the walls pulled down, except to prevent the population from holding the city against the Romans? Why, although the wealthy and the local governing power was friendly, yet was a Roman garrison left behind, but because the dominant force in the city, apart from foreign intervention, was a Hebrew or anti-Roman, and not a Gentile, force? And does not this passage, even if it stood alone, abundantly suffice to show that, whatever the division of parties may have been, Gadara was not, "to all intents and purposes, a Gentile city"? It was a city from which Vespasian apprehended an attack in his rear; and to prevent this he makes it an open city, and leaves a force in it in order that his partisans might continue to have the upper hand.

But let us not suppose that these partisans were necessarily Gentiles. I must again press the proposition that the Jews of that era, or the population observing the Mosaic law, were largely divided into peace party and war party, and that we may find the peace party acting with the Gentiles against their fellow-countrymen, in order to avoid the alternative of war. I will now refer to a passage which shows this in a manner quite conclusive. Gischala † appears to have been a city of the extreme war party, though it, too, had partisans of peace. However, it broke away, and was in consequence assailed and destroyed by a composite force of Tyrians, Sogarenes, Gadarenes, and Gabarenes. It seems

* Bell. Jud., iv, 7, 3.

† Josephus, Vita, c. x.

quite natural that the Tyrians, a Gentile people, should actively maintain the Roman domination. And the Gadarenes on this occasion acted with them. Shall this prove Gadara to be a Gentile city? Certainly not; for Gabara was a Galilæan, and, as Mr. Huxley sees, a thoroughly Jewish city, and yet it shared in the overthrow of Gischala. There can not be a clearer proof that, in certain cases, it was not the question of religion or race that determined the balance of opinion and the action of the community, but the question of war or peace. I rely, then, on the strategical movement of Vespasian to show that Gadara, an important center of Jewish population, was also in the main an important seat of Jewish military strength; most of all, perhaps, as being the center at which the rural population of Gadaris would muster for war in case of emergency.

IV. The Jewish Law in Gadaris.—Although, in inquiries of this kind, we may speak of Jewish or Hebrew populations, as Dean Milman does, to describe generally those who were adverse to the Roman power, the expressions are not quite satisfactory, because, in themselves, they involve a condition of race; whereas, to say nothing of those descendants of the ancient Canaanites who had conformed to Judaism, we find that the Mosaic law was imposed at the time of which we treat, as a consequence of conquest if not on Gentile yet on mixed populations. And the real question in respect to the Gadarene territory is not exclusively whether the population were of Hebrew extraction, but also, and indeed mainly, whether they were Jewish as being bound by the Jewish law: or, as I should like to call it, whether they were a Mosaic population. To this question let us now further look.

According to Origen,* Gadara was simply a city of Judæa. According to Josephus in one passage, it was a Grecian city, as were Hippos and Gaza.† But in another place he includes it in a great group of cities which were Syrian, Idumæan, or Phœnician,‡ and he then places it in the Syrian subdivision of that group. We are guided by the nature of the case to the meaning of these two last-named designations. There was no properly Hellenic element reckoned in the population of the country,# though there must have been a sprinkling of Greeks concerned in the administration of the kingdoms founded by Alexander's generals. As there were Phœnicians in the earliest Hellas, so now there were important Hellenic settlers in Asia, and, without doubt, a larger number of Hellenized Asiatics. In connection with the name of Gadaris, Strabo ‖ enumerates a few Greek individuals of some distinction. The case has been sufficiently explained by Grote,^ who allows as the characteristics of what was, he thinks improp-

* In Joann., p. 141.
† Bell. Jud., ii, 6, 3.
‡ Antiq., xiii, 15, 4.
# Strabo, xvi, 2.
‖ Ibid., xvi, 2, 29.
^ Hist. of Greece, xii, 362-7.

erly, called Hellenism, in the kingdoms after Alexander, the common use of Greek speech, a certain proportion of Greeks, both as inhabitants and as officers, and a partial streak of Hellenic culture. The flavor of Hellenism would be found rather at central spots than in the country at large. At Gadara it might be sustained by the bath, which probably made it a place of fashionable resort. But in this qualified or diluted sense, the name of Grecian was applied both to the Syrian and the Egyptian powers,* and the Rescript of Augustus respecting religion accordingly describes Judæa as having suffered grievously from Greek cruelty. Politically, Gadara with Hippos and Gaza † were given to Herod, and after his death, on the division of his dominions, they were re-annexed to Syria. But these were administrative changes, without any effect, so far as appears, on the laws and religion of the country. Very different was the change which ensued when, from having been a Syrian city, ‡ it was acquired by Alexander Jannæus for Judæa.# My opponent has overlooked the capital fact, that what Judæa acquired or recovered by conquest was thereupon placed under the Mosaic law. In Samaria, we may safely assume that it was there already when Jannæus conquered it. When Idumæa was subdued by his father Hyrcanus, ‖ that law was established, and the people were at once circumcised. In the case now before us the statement, though indirect, is equally conclusive. When Josephus enumerates ^ the cities conquered by Jannæus, Pella closes the list. But Pella, he adds, they destroyed, because the inhabitants would not submit to the Mosaic law (τὰ πάτρια τῶν Ἰουδαίων ἔθη). It is plain therefore that the other cities, of which Gadara was one, remained intact, because they allowed the law of Moses to become the law of the land.

Alexander Jannæus died in B. C. 79. But there is not, so far as I know, the smallest evidence that the law was altered here, any more than in Galilee or Judæa, before the time of our Saviour. Mr. Huxley indeed again and again assumes the contrary,◊ but without citing a single authority, or even taking notice of the testimony from Josephus which I have here given; and it is in the light of this passage that we have to consider the establishment of the Sanhedrim by Gibinius. He says, indeed (without any reference), that the only laws of Gadara were the Gentile laws sanctioned by the Roman suzerain. ‡ Now we know some-

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* Antiq., xvi, 6, 2. † Bell. Jud., ii, 5, 3. Antiq., xvii, 11, 4.

‡ Mr. Huxley says, "It is said to have been destroyed by captors." It is not so stated by Josephus in his account of the conquest. But it seems to have undergone some reverse before the time of Pompey (B. C. 65), by whose favor it was restored.

\# Antiq., xiii, 15, 4. ‖ Milman, Hist. Jews, ii, 28. Bell. Jud., xix, 9, 1.

^ Antiq., xiii, 15, 4. ◊ Nineteenth Century, pp. 977–8. ‡ Ibid., p. 977.

thing of the proceedings of the Roman suzerain in the time of Augustus, with regard to the Jews, not of Judæa merely, but of Asia at large and of Cyrenais, who appealed to Cæsar against what they termed Greek oppression.* The answer commends the fidelity of the Jews; it especially lauds Hyrcanus, the actual high priest; and then grants to the Jews without limit the full enjoyment of their own peculiar laws after the manner of their fathers as they were enjoying them under Hyrcanus, the high priest. This charter of continuance for the Mosaic law where it prevailed is issued during the lifetime of Herod the Great, and before the reannexation of Gadara to the Syrian province. I can hardly suppose, however, that any one would assign to that merely administrative change the effect of altering the religious law of the country, a matter in which the rule of Roman policy was that of resolute non-interference.

I conceive, then, that the conquest of Jannæus, together with the measures of Gabinius, leave no reasonable ground for doubting that the law established in Gadara at that period was the Mosaic law; and also that the Rescript of Augustus confirms this proposition. But confirmation is not required. If the religious system of the Jews was established there in the time of Gabinius, we must assume its continuance until we find it changed. Of such a change there is not, I believe, any sign before the time of our Lord.

V. Strabo.—Were it only on account of his general authority, we must not omit to notice the particulars which Strabo has supplied with respect to Gadaris. He has indeed fallen into undeniable confusion as to geographical arrangement, yet not so as to hide the real effect of some important statements.

In proceeding southward along the Syrian coast, Strabo † places Gadaris next to Joppa; then come Azotus, Ascalon, and Gaza. From Gadara proceeded five persons with Grecian names, of whom he gives a list. Now this Gadara has points of contact with the Gadara of the north, first because he speaks of it as Gadaris, a territory and not only a town; secondly, because the Greeks whom he names are known to have sprung from Gadara of Peræa. ‡ Let us now try to clear up this matter.

Proceeding from Gaza toward Pelusium, he introduces the Sirbonian Lake or morass;# but in describing by characteristic details the nature of its waters, he gives them properties which, copied from Diodorus, render it an accurate account of the Dead Sea; except that he assigns to it only two hundred stadia in length, and makes it stretch along the sea-coast, which agrees with

* Josephus, Antiq., xvi, 6, 1, 2.

† Strabo, xvi, 2, p. 759.

‡ Schürer, ii, 91.

Strabo, 763.

the Sirbonian Lake, while the length of the Dead Sea nearly reaches forty miles.* He was in fact almost wholly ignorant of the interior; and, as he confounded the Dead Sea with the Sirbonian Lake, he probably also confounded the Lake of Tiberias with the Dead Sea, both being on the line of the Jordan; and thus was led to bring Gadaris into geographical relation with it and with the coast.

The chief importance, however, of his account is to be found in a third point of contact with the true Gadaris which it presents. He describes the appropriation of this territory by a remarkable phrase. The Jews, he says, *ἐξιδιάσαντο*, made it conform to their own model; thus supporting emphatically the account drawn above from Josephus respecting the introduction of the Jewish law into the district.

It seems possible that Strabo may have been in part misled by the name of Gazara, which was in this part of Palestine, and which had likewise been Judaized upon a military conquest.

VI. Gadara and Gabara.—Vespasian, in commencing his campaign of A. D. 67, came from Antioch to Ptolemais to unite his force with that of Titus. He was there met by a party sent out of Sepphoris,† who obtained from him a Roman garrison. From this center, all Galilee was laid waste with fire and sword, there being no safety except in the cities fortified by Josephus.‡ Vespasian then carried his army of overwhelming force across the Galilæan frontier, and encamped there to try the moral effect upon the enemy. It was so powerful that Josephus,# who commanded the Jews, withdrew his force to Tiberias, at the extremity of the province.

Hereupon, says our historian,‖ Vespasian attacked the city of the Gadarenes, took it at the first assault, as it was not provided with a fighting force, and on his entry slaughtered the inhabitants of military age, for two reasons—one of which was hatred to their race. As the text stands, it proves at least a wide prevalence of Jewish nationality in the city and region of Gadaris.

It is proposed, however, to alter Gadara into Gabara, and the alteration, first suggested by Reland (1714), but not adopted by Hudson (1720) or Cardwell (1837), has received the approval of Schürer, of Milman,^ and of Robinson. ◊ I speak of it with respect, out of deference to such authorities. They do not seem to have stated conclusive or even detailed reasons, beyond the remark that, while Gabara may be within fifteen miles of Ptolemais, Gadara is out of Galilee, and more than twice the distance. Prof.

* Williams in Smith's Dictionary.

† Bell. Jud., ii, 2, 4.

‡ Ibid., 4, 1.

Ibid., 6, 2, 3.

‖ Ibid., 7, 1.

^ ii, 243.

◊ Biblical Researches, iv, 37.

Huxley has gone much further, and has set forth strategical reasons which he thinks demonstrate that Vespasian's case would have been one truly of demoniacal possession could he have passed by Gabara and marched on to Gadara. For the Roman line of march would have been between Gabara, to the north, and Jotopata, a fortified city in strong position on the south. According to Robinson,* I may observe the distance between the two is only from six to eight Roman miles. Vespasian "could not afford to leave these strongholds in the possession of the enemy,"† and from Gabara "his communications with his base could easily be threatened."

Now this statement is contradicted right and left by the facts. For first, if Gabara be the right reading, it was (and so Milman has stated it) ungarrisoned. Secondly, it was not a stronghold at all; for Josephus tells us that all Galilee was now cruelly devastated with fire and sword by the Romans, and there was nowhere any refuge, except in the cities he had fortified; of which Gabara was not one. Thirdly, in the narrow region between Gabara and Jotopata lay Sepphoris, which was held by the Romans, and was the stronghold from which all Galilee was laid waste. Fourthly, Vespasian, in defiance of his modern instructor, did leave behind him all the twelve or fourteen strong places that Josephus had fortified except one. Fifthly, he did, indeed, march against Jotopata, but for this he had a very strong reason, quite apart from fears about his base, which would under the circumstances have been chimerical; namely, that the Roman commander, Placidus, had just before failed in an attack upon it, and had been defeated and put to flight under its walls. We may now, I think, bid adieu to the strategy of Prof. Huxley.

Many a good cause, however, suffers from the use of bad arguments in its favor. It remains for me to offer, with due submission some reasons, which appear to me serious, in support of the text as it stands.

1. Josephus says Vespasian attacked "the city of the Gadarenes." So far as I know, he uses this form of expression only when the city is the center of a district (Gadaris),‡ named after it. Such was the case of Gadara, but not of Gabara. He does not call Sepphoris the city of the Sepphorites, or Gamala the city of the Gamalenes.

2. He says the place was taken at the first assault; appropriately enough for a fortified place shorn of its garrison, but not appropriate for an open town.

3. Gamala, as part of the open country of Galilee, was already in full subjection to the Romans.

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* Biblical Researches, iv, 87 (1852). † Nineteenth Century, p. 976. ‡ Bell. Jud., iii, 3, 1.

4. If, as we see, Vespasian began his operations by securing Sepphoris, the capital of Galilee, and thereby secured the province, so that the Jewish force fled to Tiberias, was it strange or unnatural that he should as his next operation secure the capital of Peræa to dominate the territory beyond Jordan ?

5. The text, as it stands, agrees with Book iv, 7, 3, in testifying to the military importance of Gadara: but the emendation makes Vespasian prefer to Jotopata a place which apparently counted for nothing in military movements.

VII. Testimony of the Evangelists.—Bidding farewell now to the text of Josephus, I do not know that we have much more assistance to expect from secular literature as to Gadara and its district. But a very important light is cast upon it by the Synoptical Gospels, and by the facts of the Old Testament history in their relation to the geographical precinct, which was also in general the ethnical limit, of our Lord's ministry upon earth.

It was, apparently, a part of the providential calling of the race of Abraham that they were to have in the first instance for themselves a distinct and separate offer of the new "glad tidings." Christ was not sent, accordingly, "but to the lost sheep of the House of Israel." It is most interesting to observe how and in what localities this offer took effect.

We naturally look in the first instance to Jerusalem and the country belonging to it. Our Lord was born, as we know, in Judæa; and the scene of the Gospel of St. John, which is in the main confined to Jerusalem and its neighborhood, and also in the main to a few continuous narratives, is principally laid there. The territory of Samaria was immediately contiguous to that of Judæa, but "the Jews had no dealings"* with the mixed race inhabiting that country, and our Saviour seems never to have exercised there more than what may be termed an accidental ministry. But the Baptism and temptation were in Galilee.† It was there that He commenced His course of miracles.‡ When the wakeful jealousy of the Pharisees made it needful for Him to quit Judæa and repair to Galilee,# "He must needs go through Samaria." Then came the (so to speak) casual meeting and discourse with the woman of Samaria, to whom He declared that salvation was of the Jews.‖ Out of the report which she carried away from Him, there grew an invitation of the Samaritans to the Saviour, praying Him to come among them:△ but He abode with them only two days, and passed on into Galilee. It is wonderful to observe how large a proportion of His ministry was ex-

* John iv, 9.

† Matt. iii, 1, 13; iv, 1.

‡ John ii, 11.

Ibid., i, 43; ii, 1-11.

‖ Ibid., v, 22.

△ Ibid., v, 40.

ercised in the north. Nor was it in the neighborhood of His own city of Nazareth, nor equally diffused over the Galilæan provinces from east to west, but was almost confined, or most largely given, to the eastern district and the close neighborhood of the Galilæan sea. Here and hereabouts we have the principal specific narratives of the calling of the Apostles,* to the number, apparently, of six. Here lay the chief scene of our Lord's active ministry: here was delivered the Sermon on the Mount. It was not only from the eastern or Galilæan side of this sea, but from Decapolis also He was followed by great multitudes; † and of Decapolis Gadara and its district were an important, and were also the nearest, part. And the fact that our Saviour selected Chorazin, Bethsaida, and Capernaum for the denunciation of the woes, ‡ on account of the privileges that they had enjoyed, at once denotes the scenes of His habitual preaching, and bears appalling testimony to its rejection. Dr. Edersheim places a group of the miracles to the east of the sea of Galilee in "a semi-heathen population," # lying much beyond Gadara. But he includes the eastern shores of the lake in the country which he describes as the principal seat of Jewish nationalism.‖ This perhaps was "Galilee of the Gentiles."ᐞ Nor did our Lord wholly avoid the coasts of Tyre and Sidon, ◊ where there were Jews in considerable numbers: but the contrast between these towns and those before named proves the comparative rarity of His visits. If they were also rare in Decapolis, "through the midst of the coasts of which" ‡ He came, we must recollect that this district, constituted under Greek authority, included Damascus and other Gentile cities. We know very well that Hebraic settlement and influence were not in our Lord's time confined to the western side of the Lake of Tiberias; for the town of Gamala ↕ on its eastern side (see Robinson's map) was sternly Jewish in the final struggle, which was also sustained by multitudes, so says Josephus, from Peræa as well as other parts of Palestine; Peræa being regularly reckoned as part of Palestine by the Rabbis. ‡

We need not doubt that there was a variable Syrian infusion in the population of this country. But we have to bear in mind that Gadaris and all its neighborhood formed part of the old promised land, and that, accordingly, the law of Moses had been in force there from a date running back fifteen hundred years; except, perhaps, at the comparatively recent period at which it had been reckoned for a time as a Syrian city. The right general

* Matt. iv, 18–22, and John i, 40–51.

† Matt. iv, 25.

‡ Ibid., xi, 21–24; Luke x, 13–15.

Life and Times of Jesus, ch. xxxiv.

‖ Ibid., ch. x, vol. i, p. 238.

ᐞ Matt. iv, 15; Isaiah ix, 1.

◊ Matt. xv, 21; Mark vii, 24.

‡ Mark vii, 31.

↕ Milman, Hist. Jews, ii, 280–6.

‡ Edersheim, i, 398.

assumption, therefore, is that the large majority, especially of the rural and laboring population, was either of genuinely Hebrew origin, or was drawn from one of those nations of Canaan who were in prior occupation. As to these, the reader of the Sacred Volume must be struck by the contrast between the pre-exilic and the post-exilic times. In the earlier history of Palestine, we are only too much reminded of their presence by the fatal fascinations of their worship. At the later period, when Judaism had set itself firmly against idolatry, they seem to be effaced; and we are left to infer that unless in Samaria, on which they imprinted a hybrid character, they had either quitted the country or had been drawn gradually within the compass of the more substantive religion, and had come to be reckoned in the number of the dominant and stronger race. Over and above these considerations, and that re-establishment of the Jewish law in the recovered cities, of which notice has already been taken, it is known that, after the two captivities, there was a powerful reflux or reaction of the Hebrew element or race in Northern Palestine, which, perhaps, was the means of establishing the broad distinction between it and Samaria. Dean Milman notices this infusion.* Samaria remained, he observes, in comparative insignificance. But the north became gradually populous, whether from the multiplication of those who had escaped deportation, or from those who returned, with the aid, perhaps, of families belonging to the southern tribes of Judah and Benjamin. We might have expected it partially to repair to the neighboring district of Samaria, and to the temple on Mount Gerizim; but, on the contrary, the inhabitants worshiped in Jerusalem, followed the fortunes of its ruling power, and fought desperately at the close for the national cause. He speaks in particular of the two Galilees, but the resistance, as Dr. Edersheim has stated, extended beyond them, and it is plain that in a portion, at least, and evidently the nearer portion, of Decapolis strong nationalism prevailed. And here we may admire the wisdom of Gabinius in providing at Gadara and Sepphoris for the local administration of the law, and thus relieving this great population from much of the inconvenience of dependence on a distant center at Jerusalem.

Quite apart from the conclusive testimony of Josephus, Mr. Huxley has evidently seen that the Synoptical Gospels, in the narrative of the swine, and in other parts, presuppose the predominance of a Hebrew nationality in the population of Gadaris. He is wise, therefore, in not only rejecting the story, but availing himself of the occasion in order to challenge the general authority of the Gospels. Conversely, all we who acknowledge their

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* Edersheim, i, 441, 2.

historical credit, must feel how improbable it is that our Lord should have carried His ministry into a really Greek or Gentile district on the only one occasion when He thought fit to run counter to the public sentiment, and to give to His action the character of a serious interference with the rights of property. How could He have ventured thus to associate Himself with the destruction of a great herd of swine, if the country was Gentile, and if those swine belonged to persons not bound by the prohibition of the Mosaic law? Might they not, and would they not, have resorted to the use of force against this unarmed as well as unauthorized intruder? But what happens is that the swineherds fly; according to all the three Evangelists, they fly; to the city, according to St. Matthew and St. Mark,* which was the seat of authority; and they tell what had happened. Why, then, if this was a land of Gentile rule, and if the swineherds were Gentiles, why was not our Saviour—since His agency was recognized —either assailed by popular violence, or called regularly to account by the law of the land; by that "Hellenic Gadarene law," † with the supposed existence of which Mr. Huxley pastures his imagination? Instead of this, without the slightest idea of an accusation against our Lord, the population, streaming forth, simply consult for their own temporal interests, and beseech Him to depart out of their coasts.‡

The supply of swine testifies indeed to the existence of a demand. It may probably testify also to the existence of a Gentile class or element in the country. The question, indeed, which relates to the use of pork as an article of diet has by no means that uniformity of color, outside the Mosaic law, which Prof. Huxley assigns to it. But it would be tedious by entering upon it to lengthen a paper already too long, for we may safely allow that among the Syrian Gentiles this diet may have been known, and may not have entailed any legal penalty.

Mr. Huxley concludes the argumentative portion of his article by insisting that the "party of Galilæans" # were foreigners in the Decapolis, and could have no title, as private individuals, even to vindicate the law. I will not argue the point, which is wholly immaterial to my purpose; and it may not be easy to draw with exactness the line up to which the private person may go of his own motion in supporting established law. I confine myself to the following propositions:

1. Both from antecedent likelihoods, and from history, there is the strongest reason to believe that the Mosaic law was the public law of Gadaris.

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* Matt. viii, 34; Mark v, 13.

† Nineteenth Century, p. 976.

‡ Matt. viii, 34; Mark v, 17; Luke viii, 37.

\# Nineteenth Century, p. 978.

2. Even if it had been relaxed as public law, yet those traditionally bound to it would not have been released from the moral obligation of obedience, and all the particulars go to show that the keepers of the swine were thus bound.

3. In the enforcement of a law which bound the conscience, our Lord had an authority such as does not belong to the private individual.

4. That the Gadarenes should have deprecated any recurrence of this interference with unlawful gains, is no more wonderful than that the population of the maritime counties of Great Britain should, in the days of our protective tariff, have been favorable to smuggling, and should even have resented, as they did, the interference of conscientious clergymen whose duty it was to denounce the practice.

5. That they should have done no more than ask for our Saviour's departure, affords of itself the strongest presumption that the action in which He co-operated, and which was certainly detrimental, was not illegal.

I submit these observations upon an historical subject, complicated by several difficulties, with all respect to those who differ from me. I do not deny that the population of Decapolis was in some sense a mixed population, partially resembling that of Samaria.* But to suppose the swineherds to have been punished by Christ for pursuing a calling which to them was an innocent one, is to run counter to every law of reasonable historic interpretation. I will not assume that I have even now exhausted the subject, though I have not knowingly omitted anything material. But Prof. Huxley is so well pleased with his own contentions, that he thinks the occasion one suitable for pointing out the intellectual superiority to which he has been led up by scientific training. I believe that I have overthrown every one of them; but I do not think the achievement such as would warrant my concluding by paying myself a compliment.—*Nineteenth Century.*

MR. FRANCIS GALTON exhibited at a recent meeting of the Anthropological Institute a number of impressions of the bulbs of the thumb and fingers of human hands, showing the curves of the papillary ridges on the skin. These impressions are an unfailing mark of the identity of a person, since they do not vary from youth to age, and are different in different individuals. Impressions of the thumb formed a kind of oath or signature among the Chinese, but were not used by them as proofs of identity. Sir W. J. Herschel, when in the Bengal civil service, introduced the practice of imprinting finger-marks as a check on personation. In Mr. Galton's impressions, which were taken from more than two thousand persons, typical forms can be discerned and traced, of which the individual forms are mere varieties. Wide departures from the typical forms are very rare.

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* Bell. Jud., iii, 3, 2.

ILLUSTRATIONS OF MR. GLADSTONE'S CONTROVERSIAL METHOD.

By Prof. T. H. HUXLEY.

THE series of essays in defense of the historical accuracy of the Jewish and Christian Scriptures contributed by Mr. Gladstone to Good Words, having been revised and enlarged by their author, appeared last year as a separate volume, under the somewhat defiant title of The Impregnable Rock of Holy Scripture.

The last of these essays, entitled Conclusion, contains an attack, or rather several attacks, couched in language which certainly does not err upon the side of moderation or of courtesy, upon statements and opinions of mine. One of these assaults is a deliberately devised attempt, not merely to rouse the theological prejudices ingrained in the majority of Mr. Gladstone's readers, but to hold me up as a person who has endeavored to besmirch the personal character of the object of their veneration. For Mr. Gladstone asserts that I have undertaken to try "the character of our Lord" (p. 268); and he tells the many who are, as I think, unfortunately, predisposed to place implicit credit in his assertions, that it has been reserved for me to discover that "Jesus was no better than a law-breaker and an evil-doer!" (p. 269).

It was extremely easy for me to prove, as I did in the pages of this Review last December, that, under the most favorable interpretation, this amazing declaration must be ascribed to extreme confusion of thought. And, by bringing an abundance of good-will to the consideration of the subject, I have now convinced myself that it is right for me to admit that a person of Mr. Gladstone's intellectual acuteness really did mistake the reprobation of the course of conduct ascribed to Jesus, in a story of which I expressly say I do not believe a word, for an attack on his character and a declaration that he was "no better than a law-breaker and evil-doer." At any rate, so far as I can see, this is what Mr. Gladstone wished to be believed when he wrote the following passage:

> I must, however, in passing, make the confession that I did not state with accuracy, as I ought to have done, the precise form of the accusation. I treated it as an imputation on the action of our Lord; he replies that it is only an imputation on the narrative of three evangelists respecting Him. The difference, from his point of view, is probably material, and I therefore regret that I overlooked it.*

Considering the gravity of the error which is here admitted, the fashion of the withdrawal appears more singular than admi-

* Nineteenth Century, February, 1891, pp. 339, 340. [Popular Science Monthly, August, 1891, p. 502.]

rable. From my "point of view"—not from Mr. Gladstone's apparently—the little discrepancy between the facts and Mr. Gladstone's carefully offensive travesty of them is "probably" (only "probably") material. However, as Mr. Gladstone concludes with an official expression of regret for his error, it is my business to return an equally official expression of gratitude for the attenuated reparation with which I am favored.

Having cleared this specimen of Mr. Gladstone's controversial method out of the way, I may proceed to the next assault, that on a passage in an article on Agnosticism (Nineteenth Century, February, 1889),* published two years ago. I there said, in referring to the Gadarene story, "Everything I know of law and justice convinces me that the wanton destruction of other people's property is a misdemeanor of evil example." On this, Mr. Gladstone, continuing his candid and urbane observations, remarks (Impregnable Rock, p. 273) that, "exercising his rapid judgment on the text," and "not inquiring what anybody else had known or said about it," I had missed a point in support of that "accusation against our Lord" which he has now been constrained to admit I never made.

The "point" in question is that "Gadara was a city of Greeks rather than of Jews, from whence it might be inferred that to keep swine was innocent and lawful." I conceive that I have abundantly proved that Gadara answered exactly to the description here given of it; and I shall show, by and by, that Mr. Gladstone has used language which, to my mind, involves the admission that the authorities of the city were not Jews. But I have also taken a good deal of pains to show that the question thus raised is of no importance in relation to the main issue.† If Gadara was, as I maintain it was, a city of the Decapolis, Hellenistic in constitution and containing a predominantly Gentile population, my case is superabundantly fortified. On the other hand, if the hypothesis that Gadara was under Jewish government, which Mr. Gladstone seems sometimes to defend and sometimes to give up, were accepted, my case would be nowise weakened. At any rate, Gadara was not included within the jurisdiction of the tetrarch of Galilee; if it had been, the Galileans who crossed over the lake to Gadara had no official status; and they had

* [Popular Science Monthly, April, 1889.]

† Neither is it of any consequence whether the locality of the supposed miracle was Gadara, or Gerasa, or Gergesa. But I may say that I was well acquainted with Origen's opinion respecting Gergesa. It is fully discussed and rejected in Riehm's Handwörterbuch. In Kitto's Bibilical Clyclopædia (II, p. 51) Prof. Porter remarks that Origen merely "conjectures" that Gergesa was indicated; and he adds: "Now, in a question of this kind, conjecture can not be admitted. We must implicitly follow the most ancient and credible testimony, which clearly pronounces in favor of **Γαδαρηνῶν**. This reading is adopted by Tischendorf, Alford, and Tregelles."

no more civil right to punish law-breakers than any other strangers.

In my turn, however, I may remark that there is a "point" which appears to have escaped Mr. Gladstone's notice. And that is somewhat unfortunate, because his whole argument turns upon it. Mr. Gladstone assumes, as a matter of course, that pig-keeping was an offense against the "law of Moses"; and, therefore, that Jews who kept pigs were as much liable to legal pains and penalties as Englishmen who smuggle brandy (Impregnable Rock, p. 274).

There can be no doubt that, according to the law, as it is defined in the Pentateuch, the pig was an "unclean" animal, and that pork was a forbidden article of diet. Moreover, since pigs are hardly likely to be kept for the mere love of those unsavory animals, pig-owning, or swineherding, must have been, and evidently was, regarded as a suspicious and degrading occupation by strict Jews, in the first century A. D. But I should like to know on what provision of the Mosaic law, as it is laid down in the Pentateuch, Mr. Gladstone bases the assumption, which is essential to his case, that the possession of pigs and the calling of a swineherd were actually illegal? The inquiry was put to me the other day; and, as I could not answer it, I turned up the article "Schwein" in Riehm's standard Handwörterbuch, for help out of my difficulty; but unfortunately without success. After speaking of the martyrdom which the Jews, under Antiochus Epiphanes, preferred to eating pork, the writer proceeds:

> It may be, nevertheless, that the practice of keeping pigs may have found its way into Palestine in the Græco-Roman time, in consequence of the great increase of the non-Jewish population; yet there is no evidence of it in the New Testament; the great herd of swine, two thousand in number, mentioned in the narratived of the possessed, was feeding in the territory of Gadara, which belonged to the Decapolis; and the prodigal son became a swineherd with the native of a far country into which he had wandered; in neither of these cases is there reason for thinking that the possessors of these herds were Jews.*

Having failed in my search, so far, I took up the next work of reference at hand, Kitto's Cyclopædia (vol. iii, 1876). There, under "Swine," the writer, Colonel Hamilton Smith, seemed at first to give me what I wanted, as he says that swine "appear to have been repeatedly introduced and reared by the Hebrew

* I may call attention, in passing, to the fact that this authority, at any rate, has no sort of doubt of the fact that Jewish law did not rule in Gadara (indeed, under the head of "Gadara," in the same work, it is expressly stated that the population of the place consisted "predominantly of heathens"), and that he scouts the notion that the Gadarene swineherds were Jews.

people,* notwithstanding the strong prohibition in the law of Moses (Isaiah lxv, 4"). But, in the first place, Isaiah's writings form no part of the "law of Moses"; and, in the second place, the people denounced by the prophet in this passage are neither the possessors of pigs, nor swineherds, but those "which eat swine's flesh and broth of abominable things is in their vessels." And when, in despair, I turned to the provisions of the law itself, my difficulty was not cleared up. Leviticus xi, 8 (Revised Version) says, in reference to the pig and other unclean animals: "Of their flesh ye shall not eat, and their carcasses ye shall not touch." In the revised version of Deuteronomy xiv, 8, the words of the prohibition are identical, and a skillful refiner might possibly satisfy himself, even if he satisfied nobody else, that "carcass" means the body of a live animal as well as of a dead one; and that, since swineherds could hardly avoid contact with their charges, their calling was implicitly forbidden.† Unfortunately, the authorized version expressly says "dead carcass"; and thus the most rabbinically minded of reconcilers might find his casuistry foiled by that great source of surprises, the "original Hebrew." That such check is at any rate possible, is clear from the fact that the legal uncleanness of some animals, as food, did not interfere with their being lawfully possessed, cared for, and sold by Jews. The provisions for the ransoming of unclean beasts (Leviticus xxvii, 27) and for the redemption of their sucklings (Numbers xviii, 15) sufficiently prove this. As the late Dr. Kalisch has observed in his Commentary on Leviticus, Part II, p. 129, note:

> Though asses and horses, camels and dogs, were kept by the Israelites, they were, to a certain extent, associated with the notion of impurity; they might be turned to profitable account by their labor or otherwise, but in respect to food they were an abomination.

The same learned commentator (*loc. cit.*, p. 88) proves that the Talmudists forbade the rearing of pigs by Jews, unconditionally and everywhere; and even included it under the same ban as the study of Greek philosophy, "since both alike were considered to lead to the desertion of the Jewish faith." It is very possible, indeed probable, that the Pharisees of the fourth decade of our first century took as strong a view of pig-keeping as did their spiritual descendants. But, for all that, it does not follow that the practice was illegal. The stricter Jews could not have despised and hated swineherds more than they did publicans; but,

* The evidence adduced, so far as post-exile times are concerned, appears to me insufficient to prove this assertion.

† Even Leviticus xi, 26, cited without reference to the context, will not serve the purpose; because the swine *is* "cloven-footed" (Lev. xi, 7).

so far as I know, there is no provision in the law against the practice of the calling of a tax-gatherer by a Jew. The publican was in fact very much in the position of an Irish process-server at the present day—more, rather than less, despised and hated on account of the perfect legality of his occupation. Except for certain sacrificial purposes, pigs were held in such abhorrence by the ancient Egyptians that swineherds were not permitted to enter a temple, or to intermarry with other castes; and any one who had, even accidentally, touched a pig was unclean. But these very regulations prove that pig-keeping was not illegal; it merely involved certain civil and religious disabilities. For the Jews, dogs were typically "unclean" animals; but, when that eminently pious Hebrew, Tobit, "went forth" with the angel "the young man's dog" went "with them" (Tobit v, 16) without apparent remonstrance from the celestial guide. I really do not see how an appeal to the law could have justified any one in drowning Tobit's dog, on the ground that his master was keeping and feeding an animal quite as "unclean" as any pig. Certainly the excellent Raguel must have failed to see the harm of dog-keeping, for we are told that, on the travelers' return homeward, "the dog went after them" (xi, 4).

Until better light than I have been able to obtain is thrown upon the subject, therefore, it is obvious that Mr. Gladstone's argumentative house has been built upon an extremely slippery quicksand; perhaps even has no foundation at all.

Yet another "point" does not seem to have occurred to Mr. Gladstone, who is so much shocked that I attach no overwhelming weight to the assertions contained in the synoptic Gospels, even when all three concur. These Gospels agree in stating, in the most express, and, to some extent verbally identical, terms, that the devils entered the pigs at their own request,* and the third Gospel (viii, 31) tells us what the motive of the demons was in asking the singular boon: "They entreated him that he would not command them to depart into the abyss." From this, it would seem that the devils thought to exchange the heavy punishment of transportation to the abyss, for the lighter penalty of imprisonment in swine. And some commentators, more ingenious than respectful to the supposed chief actor in this extraordinary fable, have dwelt, with satisfaction, upon the very unpleasant quarter of an hour which the evil spirits must have had, when the headlong rush of their maddened tenements convinced them how completely they were taken in. In the whole story, there is not one

* First Gospel: "And the devils *besought him* saying, If thou cast us out send us away *into* the herd of swine." Second Gospel: "They *besought him* saying, Send us *into* the swine." Third Gospel: "They *entreated him* that he would give them leave to enter *into* them."

solitary hint that the destruction of the pigs was intended as a punishment of their owners, or of the swineherds. On the contrary, the concurrent testimony of the three narratives is to the effect that the catastrophe was the consequence of diabolic suggestion. And, indeed, no source could be more appropriate for an act of such manifest injustice and illegality.

I can but marvel that modern defenders of the faith should not be glad of any reasonable excuse for getting rid of a story which, if it had been invented by Voltaire, would have justly let loose floods of orthodox indignation.

Thus, the hypothesis to which Mr. Gladstone so fondly clings finds no support in the provisions of the "law of Moses" as that law is defined in the Pentateuch; while it is wholly inconsistent with the concurrent testimony of the synoptic Gospels, to which Mr. Gladstone attaches so much weight. In my judgment, it is directly contrary to everything which profane history tells us about the constitution and the population of the city of Gadara; and it commits those who accept it to a story which, if it were true, would implicate the founder of Christianity in an illegal and inequitable act.

Such being the case, I consider myself excused from following Mr. Gladstone through all the meanderings of his late attempt to extricate himself from the maze of historical and exegetical difficulties in which he is entangled. I content myself with assuring those who, with my paper (not Mr. Gladstone's version of my arguments) in hand, consult the original authorities, that they will find full justification for every statement I have made. But in order to dispose those who can not, or will not, take that trouble, to believe that the proverbial blindness of one that judges his own cause plays no part in inducing me to speak thus decidedly, I beg their attention to the following examination, which shall be as brief as I can make it, of the seven propositions in which Mr. Gladstone professes to give a faithful summary of my "errors."

When, in the middle of the seventeenth century, the Holy See declared that certain propositions contained in the works of Bishop Jansen were heretical, the Jansenists of Port Royal replied that, while they were ready to defer to the Papal authority about questions of faith and morals, they must be permitted to judge about questions of fact for themselves; and that, really, the condemned propositions were not to be found in Jansen's writings. As everybody knows, his Holiness and the Grand Monarque replied to this surely not unreasonable plea after the manner of Lord Peter in the Tale of a Tub. It is, therefore, not without some apprehension of meeting with a similar fate, that I put in a like plea against Mr. Gladstone's Bull. The seven propositions declared to be false and condemnable, in that kindly and gentle way which so pleasantly compares with the authoritative style of the Vatican (No. 5 more particularly), may or may not be true. But they are not to be found in anything I have written. And some of them diametrically contravene that which I have written. I proceed to prove my assertion:

PROP. 1. *Throughout the paper he confounds together what I had distinguished, namely, the city of Gadara and the vicinage attached to it, not as a mere pomœrium, but as a rural district.*

In my judgment, this statement is devoid of foundation. At p. 972 of my paper on The Keepers of the Herd of Swine I point out, at some length, that, "in accordance with the ancient Hellenic practice," each city of the Decapolis must have been "surrounded by a certain amount of territory amenable to its jurisdiction"; and, to enforce this conclusion, I quote what Josephus says about the "villages that belonged to Gadara and Hippos." As I understand the term *pomerium* or *pomœrium*,* it means the space which, according to Roman custom, was kept free from buildings, immediately within and without the walls of a city; and which defined the range of the *auspicia urbana*. The conception of a *pomœrium* as a "vicinage attached to" a city, appears to be something quite novel and original. But then, to be sure, I do not know how many senses Mr. Gladstone may attach to the word "vicinage."

Whether Gadara had a *pomœrium*, in the proper technical sense, or not, is a point on which I offer no opinion. But that the city had a very considerable "rural district" attached to it, and, notwithstanding its distinctness, amenable to the jurisdiction of the Gentile municipal authorities, is one of the main points of my case.

PROP. 2. *He more fatally confounds the local civil government and its following, including, perhaps, the whole wealthy class and those attached to it, with the ethnical character of the general population.*

Having survived confusion No. 1, which turns out not to be on my side, I am now confronted in No. 2 with a "more fatal" error—and so it is, if there be degrees of fatality; but, again, it is Mr. Gladstone's and not mine. It would appear from this proposition (about the grammatical interpretation of which, however, I admit there are difficulties), that Mr. Gladstone holds that the "local civil government and its following among the wealthy," were ethnically different from the "general population." On p. 348, he further admits that the "wealthy and the local govern-

* See Marquardt, Römische Staatsverwaltung, Bd. III, p. 408.

ing power" were friendly to the Romans. Are we then to suppose that it was the persons of Jewish "ethnical character" who favored the Romans, while those of Gentile "ethnical character" were opposed to them? But if that supposition is absurd, the only alternative is that the local civil government was ethnically Gentile. That is exactly my contention.

At pp. 973 and 976 of the Keepers of the Herd of Swine I have fully discussed this question of the ethnical character of the general population. I have shown that, according to Josephus, who surely ought to have known, Gadara was as much a Gentile city as Ptolemais; I have proved that he includes Gadara among the cities "that rose up against the Jews that were among them," which is a pretty definite expression of his belief that the "ethnical character of the general population" was Gentile. There is no question here of Jews of the Roman party fighting with Jews of the Zealot party, as Mr. Gladstone suggests. It is the non-Jewish and anti-Jewish general population which rises up against the Jews who had settled "among them."

PROP. 3. *His one item of direct evidence as to the Gentile character of the city refers only to the former and not to the latter.*

More fatal still. But, once more not to me. I adduce not one, but a variety of "items" in proof of the non-Judaic character of the population of Gadara: the evidence of history; that of the coinage of the city; the direct testimony of Josephus, just cited—to mention no others. I repeat, if the wealthy people and those connected with them—the "classes" and the "hangers on" of Mr. Gladstone's well-known taxonomy—were, as he appears to admit they were, Gentiles; if the "civil government" was in their hands, as the coinage proves it was—what becomes of Mr. Gladstone's original proposition in The impregnable Rock of Scripture that "the population of Gadara, and still less (if less may be) the population of the neighborhood," were "Hebrews bound by the Mosaic law"? And what is the importance of estimating the precise proportion of Hebrews who may have resided, either in the city of Gadara, or in its dependent territory, when, as Mr. Gladstone now seems to admit (I am careful to say "seems"), the government, and consequently the law which ruled in that territory and defined civil right and wrong, was Gentile and not Judaic? But perhaps Mr. Gladstone is prepared to maintain that the Gentile "local civil government" of a city of the Decapolis administered Jewish law; and showed their respect for it, more particularly, by stamping their coinage with effigies of the emperors.

In point of fact, in his haste to attribute to me errors which I have not committed, Mr. Gladstone has given away his case.

PROP. 4. *He fatally confounds the question of political party with those of nationality and of religion, and assumes that those who* *took the side of Rome in the factions that prevailed could not be subject to the Mosaic law.*

It would seem that I have a feline tenacity of life; once more, a "fatal" error. But Mr. Gladstone has forgotten an excellent rule of controversy: say what is true, of course, but mind that it is decently probable. Now it is not decently probable, hardly indeed conceivable, that any one who has read Josephus, or any other historian of the Jewish war, should be unaware that there were Jews (of whom Josephus himself was one), who "Romanized" and, more or less openly, opposed the war party. But, however that may be, I assert that Mr. Gladstone neither has produced, nor can produce, a passage of my writing which affords the slightest foundation for this particular article of his indictment.

PROP. 5. *His examination of the text of Josephus is alike one-sided, inadequate, and erroneous.*

Easy to say, hard to prove. So long as the authorities whom I have cited are on my side, I do not know why this singularly temperate and convincing dictum should trouble me. I have yet to become acquainted with Mr. Gladstone's claims to speak with an authority equal to that of scholars of the rank of Schürer, whose obviously just and necessary emendations he so unceremoniously pooh-poohs.

PROP. 6. *Finally, he sets aside, on grounds not critical or historical, but purely subjective, the primary historical testimony on the subject, namely, that of the three synoptic Evangelists, who write as contemporaries and deal directly with the subject, neither of which is done by any other authority.*

Really this is too much! The fact is, as anybody can see who will turn to my article of February, 1889 [Popular Science Monthly, April, 1889], out of which all this discussion has arisen, that the arguments upon which I rest the strength of my case touching the swine-miracle, are exactly "historical" and "critical." Expressly, and in words that can not be misunderstood, I refuse to rest on what Mr. Gladstone calls "subjective" evidence. I abstain from denying the possibility of the Gadarene occurrence, and I even go so far as to speak of some physical analogies to possession. In fact, my quondam opponent, Dr. Wace, shrewdly, but quite fairly, made the most of these admissions, and stated that I had removed the only "consideration which would have been a serious obstacle" in the way of his belief in the Gadarene story.*

So far from setting aside the authority of the Synoptics on "subjective" grounds, I have taken a great deal of trouble to

* Nineteenth Century, March, 1889, p. 362 [Popular Science Monthly, May, 1889, p. 76].

show that my non-belief in the story is based upon what appears to me to be evident: firstly, that the accounts of the three synoptic Gospels are not independent, but are founded upon a common source; secondly, that even if the story of the common tradition proceeded from a contemporary, it would still be worthy of very little credit, seeing the manner in which the legends about mediæval miracles have been propounded by contemporaries. And, in illustration of this position, I wrote a special essay about the miracles reported by Eginhard.*

In truth, one need go no further than Mr. Gladstone's sixth proposition to be convinced that contemporary testimony, even of well-known and distinguished persons, may be but a very frail reed for the support of the historian, when theological prepossession blinds the witness.†

PROP. 7. *And he treats the entire question, in the narrowed form in which it arises upon secular testimony, as if it were capable of a solution so clear and summary as to warrant the use of the extremest weapons of controversy against those who presume to differ from him,*

The six heretical propositions which have gone before are enunciated with sufficient clearness to enable me to prove without any difficulty that, whosesoever they are, they are not mine. But number seven, I confess, is too hard for me. I can not undertake to contradict that which I do not understand.

What is the "entire question" which "arises" in a "narrowed form" upon "secular testimony"? After much guessing, I am fain to give up the conundrum. The "question" may be the

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* The Value of Witness to the Miraculous. Nineteenth Century, March, 1889. [Popular Science Monthly, September, 1889.]

† I can not ask the editor of this Review to reprint pages of an old article—but the following passages sufficiently illustrate the extent and the character of the discrepancy between the facts of the case and Mr. Gladstone's account of them:

"Now, in the Gadarene affair, I do not think I am unreasonably skeptical, if I say that the existence of demons who can be transferred from a man to a pig does thus contravene probability. Let me be perfectly candid. I admit I have no *a priori* objection to offer. . . . I declare, as plainly as I can, that I am unable to show cause why these transferable devils should not exist." . . . (Agnosticism, Nineteenth Century, 1889, p. 177.) [Popular Science Monthly, April, 1889, pp. 758, 759.]

"What then do we know about the originator, or originators, of this groundwork—of that threefold tradition which all three witnesses (in Paley's phrase) agree upon—that we should allow their mere statements to outweigh the counter-arguments of humanity, of common sense, of exact science, and to imperil the respect which all would be glad to be able to render to their Master?" (Ibid., p. 175.) [Popular Science Monthly, p. 756.]

I then go on through a couple of pages to discuss the value of the evidence of the Synoptics on critical and historical grounds. Mr. Gladstone cites the essay from which these passages are taken, whence I suppose he has read it; though, it may be, that he shares the impatience of Cardinal Manning where my writings are concerned. Such impatience may account for, though it will not excuse, his sixth proposition.

ownership of the pigs or the ethnological character of the Gadarenes; or the propriety of meddling with other poeple's property without legal warrant. And each of these questions might be so "narrowed" when it arose "on secular testimony" that I should not know where I was. So I am silent on this part of the proposition.

But I do dimly discern in the latter moiety of this mysterious paragraph a reproof of that use of "the extremest weapons of controversy" which is attributed to me. Upon which I have to observe that I guide myself in such matters very much by the maxim of a great statesman, "*Do ut des.*" If Mr. Gladstone objects to the employment of such weapons in defense, he would do well to abstain from them in attack. He should not frame charges which he has, afterward, to admit are erroneous, in language of carefully calculated offensiveness (Impregnable Rock, pp. 269, 270); he should not assume that persons with whom he disagrees are so wrecklessly unconscientious as to evade the trouble of inquiring what has been said or known about a great question (Impregnable Rock, p. 273); he should not qualify the results of careful thought as "hand-over-head reasoning" (Impregnable Rock, p. 274); he should not, as in the extraordinary propositions which I have just analyzed, make assertions respecting his opponent's position and arguments which are contradicted by the plainest facts.

Persons who, like myself, having spent their lives outside the political world, yet take a mild and philosophical concern in what goes on in it, often find it difficult to understand what our neighbors call the psychological moment of this or that party leader; and are, occasionally, loath to believe in the seeming conditions of certain kinds of success. And, when some chieftain, famous in political warfare, adventures into the region of letters or of science, in full confidence that the methods which have brought fame and honor in his own province will answer there, he is apt to forget that he will be judged by these people; on whom rhetorical artifices have long ceased to take effect; and to whom, mere dexterity in putting together cleverly ambiguous phrases, and even the great art of offensive misrepresentation, are unspeakably wearisome. And, if that weariness finds its expression in sarcasm, the offender really has no right to cry out. Assuredly ridicule is no test of truth, but it is the righteous meed of some kinds of error. Nor ought the attempt to confound the expression of a revolted sense of fair dealing with arrogant impatience of contradiction, to restrain those to whom "the extreme weapons of controversy" come handy from using them. The function of police in the intellectual, if not in the civil, economy may sometimes be legitimately discharged by volunteers.

Some time ago, in one of the many criticisms with which I am favored, I met with the remark that, at our time of life, Mr. Gladstone and I might be better occupied than in fighting over the Gadarene pigs. And, if these too famous swine were the only parties to the suit, I, for my part, should fully admit the justice of the rebuke. But, under the beneficent rule of the Court of Chancery, in former times, it was not uncommon that a quarrel about a few perches of worthless land ended in the ruin of ancient families and the ingulfing of great estates; I think that our admonisher failed to observe the analogy—to note the momentous consequences of the judgment which may be awarded in the present apparently insignificant action *in re* the swineherds of Gadara.

The immediate effect of such judgment will be the decision of the question whether the men of the nineteenth century are to adopt the demonology of the men of the first century as divinely revealed truth, or to reject it as degrading falsity. The reverend Principal of King's College has delivered his judgment in perfectly clear and candid terms. Two years since, Dr. Wace said that he believed the story as it stands; and consequently he holds, as a part of divine revelation, that the spiritual world comprises devils, who, under certain circumstances, may enter men and be transferred from them to four-footed beasts. For the distinguished Anglican divine and biblical scholar, that is part and parcel of the teachings respecting the spiritual world which we owe to the founder of Christianity. It is an inseparable part of that Christian orthodoxy which, if a man rejects, he is to be considered and called an "infidel." According to the ordinary rules of interpretation of language, Mr. Gladstone must hold the same view.

If antiquity and universality are valid tests of the truth of any belief, no doubt this is one of the beliefs so certified. There are no known savages, nor people sunk in the ignorance of partial civilization, who do not hold them. The great majority of Christians have held them and still hold them. Moreover, the oldest records we possess of the early conceptions of mankind in Egypt and in Mesopotamia prove that exactly such demonology, as is implied in the Gadaran story, formed the substratum, and, among the early Accadians, apparently the greater part, of their supposed knowledge of the spiritual world. M. Lenormant's profoundly interesting work on Babylonian magic and the magical texts given in the appendix to Prof. Sayce's Hibbert Lectures leave no doubt on this head. They prove that the doctrine of possession, and even the particular case of pig possession,* were firmly believed in

* The wicked, before being annihilated, returned to the world to disturb men; they entered into the body of unclean animals, "often that of a pig, as on the sarcophagus of Seti I in the Soane Museum."—LENORMANT, Chaldean Magic, p. 88, editorial note.

by the Egyptians and the Mesopotamians before the tribes of Israel invaded Palestine. And it is evident that these beliefs, from some time after the exile and probably much earlier, completely interpenetrated the Jewish mind and thus became inseparably interwoven with the fabric of the synoptic Gospels.

Therefore, behind the question of the acceptance of the doctrines of the oldest heathen demonology as part of the fundamental beliefs of Christianity, there lies the question of the credibility of the Gospels, and of their claim to act as our instructors, outside that ethical province in which they appeal to the consciousness of all thoughtful men. And still, behind this problem, there lies another—how far do these ancient records give a sure foundation to the prodigious fabric of Christian dogma which has been built upon them by the continuous labors of speculative theologians during eighteen centuries?

I submit that there are few questions before the men of the rising generation on the answer to which the future hangs more fatally than this. We are at the parting of the ways. Whether the twentieth century shall see a recrudescence of the superstitions of mediæval papistry, or whether it shall witness the severance of the living body of the ethical ideal of prophetic Israel from the carcass, foul with savage superstitions and cankered with false philosophy, to which the theologians have bound it, turns upon their final judgment of the Gadarene tale.

The gravity of the problems ultimately involved in the discussion of the legend of Gadara will, I hope, excuse a persistence in returning to the subject, to which I should not have been moved by merely personal considerations.

With respect to the diluvial invective which overflowed thirty-three pages of this Review last January, I doubt not that it has a catastrophic importance in the estimation of its author. I, on the other hand, may be permitted to regard it as a mere spate; noisy and threatening while it lasted, but forgotten almost as soon as it was over. Without my help, it will be judged by every instructed and clear-headed reader; and that is fortunate, because, were aid necessary, I have cogent reasons for withholding it.

In an article characterized by the same qualities of thought and diction, entitled A Great Lesson which appeared in this Review for September, 1887, the Duke of Argyll, firstly, charged the whole body of men of science interested in the question with having conspired to ignore certain criticisms of Mr. Darwin's theory of the origin of coral reefs; and, secondly, he asserted that some person unnamed had "actually induced" Mr. John

Murray to delay the publication of his views on that subject "for two years."

It was easy for me and for others to prove that the first statement was not only, to use the Duke of Argyll's favorite expression, "contrary to fact," but that it was without any foundation whatever. The second statement rested on the Duke of Argyll's personal authority. All I could do was to demand the production of the evidence for it. Up to the present time, so far as I know, that evidence has not made its appearance; nor has there been any withdrawal of, or apology for, the erroneous charge.

Under these circumstances, most people will understand why the Duke of Argyll may feel quite secure of having the battle all to himself, whenever it pleases him to attack me.—*Nineteenth Century.*

HEAD-FLATTENING AS SEEN AMONG THE NAVAJO INDIANS.

By Dr. R. W. Shufeldt.

A LITTLE over a year ago, when in the northwestern part of New Mexico, the opportunity was afforded the writer to make a great many observations upon the Navajo Indians, the tribe found in that section of the country. Those studies, which took into consideration in several instances their simple arts and industries, have been published in various quarters; but a widely different field of research, for which they also afforded the material, especially interested me at the time, and this was the subject of their craniology.

On a number of occasions fine specimens of the skulls of those Indians, of both sexes and all ages, fell into my hands; while the peculiar distortion several of these presented at once commanded my attention. In the main this distortion consisted in either a direct or an oblique posterior flattening of the skull; and that it was a characteristic to be seen in many of the heads of the representatives of that tribe of North American Indians has long been a well-ascertained fact.

For an equal length of time has the cause of this flattening of the skull among the Navajos generally been attributed to a pressure brought to bear over the region in question during the infancy of the individual exhibiting it. This was also my own preconceived opinion, an opinion which had become more or less fixed by all my previous reading upon the subject, but not through personal examination of the proper material itself, under the most favorable circumstances possible.

Among the first if not the first specimen that came into my possession was the skull of an adult male Navajo, and, after a careful study of it, it was presented to the craniological section of the Anatomical Museum of the University of Edinburgh, where it now is. This was early in 1886; and in the April number of that year of the Journal of Anatomy and Physiology of London, the writer published his observations upon that skull, the paper being illustrated by a fine lithographic plate presenting the four principal views of the same.

In the same number of the Journal which I have named above, Prof. Sir William Turner contributed an additional note upon the same skull, wherein he says that it "presented a well-marked parieto-occipital flattening, obviously due to artificial pressure, which had been applied so as to cause the suprasquamous part of the occipital bone and the posterior three fourths of the parietal to slope upward and forward."

"The frontal region did not exhibit any flattening, so that in this individual, and it may be in his tribe of Indians, the pressure applied in infancy was apparently limited to the back of the head. Owing to this artificial distortion, the longitudinal diameter of the head was diminished, and the cephalic index, 94·6, computed from Dr. Shufeldt's measurements of the length and breadth, was therefore higher than it would have been in an undeformed skull. The cranium was hyperbrachycephalic."

This, and much more, was set forth in Dr. Turner's valuable "note" upon my specimen; but it was hard for me to see how a baby could have pressure applied to the back of its skull of sufficient amount to produce the flattening found, unless there was a *counter-pressure* applied at the *opposite* aspect of the skull, which naturally would produce there perhaps a similar flattening or some other distortion, and this latter deformity is never seen to exist in the skulls of the Navajos. As I say, at the time I read Dr. Turner's note, I was in a position to examine this question quite thoroughly, as these Indians were living all about me, and I saw the Navajo women daily with their infants strapped in their cradles.

It will be seen in the sequel that my subsequent observations in the premises compelled me to hold a different opinion from the one advanced above by so eminent an authority as is Sir William Turner.

Another skull which soon fell into my hands was a fine specimen from a young Navajo girl of some six or seven years of age, and it showed this peculiar flattening to a very marked degree. By the aid of my camera I am enabled to present herewith two figures of the skull of this individual, showing the flattening from two views.

Upon every occasion where I was permitted to do so, careful examinations were made of the heads of these people, both living and dead, as well as the methods of strapping the infant Navajos in their cradles, and indeed all else that might tend to throw light upon the subject.

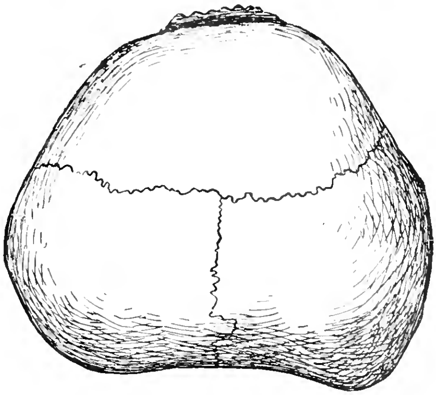


Fig. 1.—Direct Superior View of the Skull of a Navajo Indian Child of about Six and a Half Years of Age, and probably a Female. (Considerably reduced.)

Of some two or three dozen children of all ages, from the infant upward, that I have thus examined, I have yet to find a case wherein the mother has not taken the special precaution to place a soft and ample pad in the cradle in such a manner as to fully protect the back of the child's head. Moreover, I have yet to see a case, except for a few days or more in the very youngest of babies, where the head is strapped at all. On the other hand, this part of the body is allowed all possible freedom, as may be seen in Fig. 3, illustrating the paper. This picture is from a photograph of the Navajo woman "Chuna," who lives near Fort Wingate, New Mexico, and it shows exactly the general method employed by the mothers of this tribe of Indians in strapping their babies in the cradle, and also their mode of carrying the cradle.* It will at once be observed that the head of the child is perfectly free, and that it has been supplied by a thick and soft pillow at the back of it, whereas the body and limbs have been strapped up almost to the last degree.

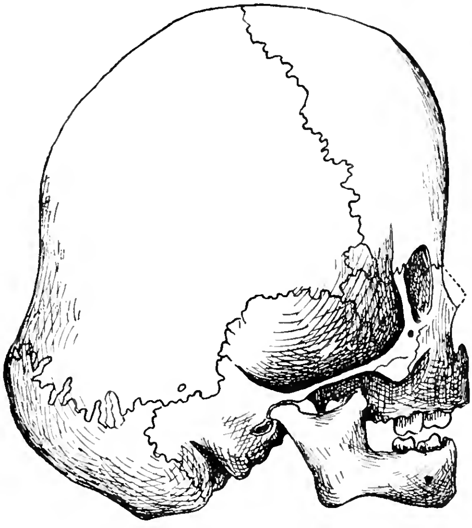


Fig. 2.—Right Lateral Aspect of the same Skull shown in Fig. 1.

* The cradle shown in this illustration is now in the collections of the United States National Museum, at Washington, where it was deposited by the writer.

This child, being a "half-breed," has light, thin hair, through which the general form of its skull could be easily examined; but,

Fig. 3.—Navajo Woman carrying her Baby.

after the most careful measurements, I failed to detect any flattening whatever of the occipital region of the head. In examining the full-blooded infants of different ages of this tribe, I occasionally found one wherein I thought I could satisfactorily determine that the back of its head was unduly flattened, but it was by no means always the case.

Another thing must be remembered, and that is that these Navajo women do not always keep their infants thus strapped up in their cradles, and this fact goes to sustain that whatever pressure is brought to bear against the backs of their heads is *not a constant* one. We often see little Navajo babies playing about for hours together, and that at a time when they are scarcely able to walk.

Among the older children, as well as I could do so through their thick mats of hair, I have on one or more occasions satisfied myself that the hinder region of their heads was flattened, though it was but rarely the case that one was met with that exhibited this to a degree found in the skull figured in the present paper.

Such examinations as I have been enabled to make thus far very thoroughly convince me that this head-flattening is *not* due to the mode of strapping that part of the body employed by the Navajo mothers of the present day. In ages or generations gone by the ancestors of those Indians may have resorted to a very different method of fastening the infant's head in its cradle: perhaps it may have been more firmly fixed by thongs, and a pressure brought to bear upon the occiput, and that of a nature to produce the distortion in question; but so far as the writer is aware we have no such record for this tribe. How much heredity may have to do with it, then, we are not fully prepared to answer. And in any event we must bear in mind, when considering this matter, that the distortion, if it may be so termed, does not occur by any means in the skulls of all the representatives of the Navajos; nor is it limited to either sex; nor does it disappear as age advances; nor does the plane of the flattened surface of the occiput always bear the same relation to other planes of the skull, as the flattening may be central, or it may be more or less lateral, and so on; and, finally, it varies greatly in degree.

That skull-distortion, due to various modes of artificial pressure, is to be seen among divers peoples still in existence, as well as in the preserved skulls of former races that inhabited the earth, there can be no question; and it would seem, in the light of what we have attempted to bring out in this paper, that one of the most interesting points to decide with respect to it is whether such a feature can become hereditary.

At all events, the subject is full of interest, and will bear, it appears to me, further and fuller investigation.

THE RELATIONS OF ABSTRACT RESEARCH TO PRACTICAL INVENTION.*

By F. W. CLARKE.

A HUNDRED years ago, just after the first American patent was issued, two other events, fitly to be mentioned here, became a part of history. In 1791 Galvani published his famous book on animal electricity; and at about the same time the Royal Society gave its highest honor, the award of the Copley Medal, to Volta. Between these events and the passage of our first patent law no connection was then apparent, nor for many years afterward did any relation become obvious. The patent system dealt with affairs of practical utility, while Galvani and Volta were mere visionaries, prying into matters of only speculative interest, and of no real value or importance to anybody. Indeed, Galvani was ridiculed throughout Europe as "the frogs' dancing-master," so remote from all material considerations, so useless to all outward seeming, were his investigations.

In spite of ridicule and indifference, however, the unpractical researches went on, from step to step, from discovery to discovery, until at last they ripened into invention. Galvani and Volta had worthy successors—Oersted, Ampère, Ohm, Faraday, Henry, and others—all devoted to knowledge for its own sake, and caring little for any reward other than the consciousness of achievement. The voltaic pile, the galvanic battery, and the electro-magnet were added to the resources of science; facts, principles, and laws came into recognition; and suddenly a relation of the work done to the work the great world was doing became manifest. Nearly half a century was passed in these preliminaries, and then came the inventions of electro-metallurgy, of the telegraph, and of all the hurrying swarm of wonders that mark this "age of electricity." Suddenly the Patent Office became a center of interest in what at the date of its foundation had been apparently remote from its purposes; and to-day, grown from the germs of a century ago, we see one of the chief objects of its activity. All now know the merit of Galvani's work, and yet its lesson of history is far too seldom realized. Every true investigator in the domain of pure science is met with monotonously recurrent questions as to the practical purport of his studies; and rarely can he find an answer expressible in terms of commerce. If utility is not immediately in sight, he is pitied as a dreamer, or blamed as a spendthrift of time; for the questioning man of affairs can recognize only affairs, and to him speculations not convertible into coin of

* An address delivered at the Patent Centennial in Washington, April 9, 1891.

the realm must naturally seem profitless. High aims count for little or nothing—results, and tangible results at that, are wanted.

It would be easy to multiply instances in illustration of my meaning. For example, iodine, discovered in 1812 by Courtois, was for many years a chemical curiosity. Why should any one waste his time in the study of so useless a body? To-day industries unknown to Courtois, born since his day, find in iodine one of their most necessary appliances. Photography, one of the arts in which iodine is useful, itself grew out of researches which were seemingly useless when made; and the camera, its most essential implement, was once only a philosopher's plaything. Investigations which had only the pursuit of truth for its own sake as a justification, brought rainbows of color out of coal; and coal-tar, not forty years ago a nuisance to be thrown away, is now a source of profit and prodigal of beauty. From the same hopeless material, through researches still unaimed at profit, have come the latest and best additions to our *materia medica;* and so again the methods of Science, as applied by her highest votaries, are vindicated by the fruits they bear. In short, every department of invention, every advance in civilization, owes much to the student; no industry is independent of the results won by purely abstract research. Even the most trivial details of modern life are affected by the work of the scientific investigator; luxuries and necessaries alike are influenced; and so obtrusively evident is this truth to most of us, that, taking it for granted, we daily ask, "What next?" Indeed, our gratitude to Science is often manifested in that cynical form which has been wittily defined as "a lively sense of favors yet to be received." We expect more in the future than we have realized in the past, and, as the marvels of the last century become commonplace, we look for new wonders which shall be even greater. The magic of the ancients is already outdone, and still the tide of discovery has not reached its flood. To preserve what we have gained, and to insure the promise of the years to come, is the problem before us. Speaking in the interest of future invention we may fairly ask, How best shall the work of investigation be furthered?

It is an old saying, and one partly true, that what has been, shall be. We may, therefore, consider through what agencies science has heretofore grown, and so recognize the foundations upon which building is possible. These agencies, briefly summarized, are as follows: First, individual enterprise; second, schools and universities; third, learned societies and endowments; fourth, government aid. Like nearly all classifications this list is imperfect, for it represents only one phase of the truth; and the several items, far from being distinct, shade into one another through many gradations of circumstance. Among them all, individual enterprise comes properly first, for, without that, without the influence of guiding spirits, the other agencies must fail. In a restricted sense, however, except perhaps as regards the beginnings of science, individual enterprise is the weakest force of all. To the modern investigator leisure and opportunities are necessary; in chemistry and physics, at least, apparatus and laboratories are indispensable; and few men working alone can command either the needful time or the bare material resources. During this century nine tenths of the great discoveries have been made by men with institutions back of them, through the aid of which the work was rendered possible. Wealth, scholarship, ability, and the spirit of research too seldom go together; and happy is the man in whom all these conditions are fortunately united. Under our second heading, in the shelter of schools and universities, the science of to-day has chiefly been developed.

The truth of my last statement may be verified by a reference to the files of those standard scientific journals in which original researches are recorded, or by scrutinizing in detail the history of any great discovery. In either case, whether we consider this country or Europe, the university work will be found to predominate overwhelmingly, and for obvious reasons. Every true university is something more than a distributor of knowledge; it is a producer of knowledge also; and in Germany, where the university system is most fully developed, the two functions are equally recognized. A German student, aspiring to academic honors, must do original work, and the professors' chairs are always filled from among the men who have most distinguished themselves as investigators. A chemist who had done nothing for pure science could hardly be recognized in Germany; not one of the higher professional positions would be within his reach; erudition alone, unsustained by evidence of creative ability, would do little for his advancement. In consequence of this policy, Germany now leads the scientific world; and, in consequence of that leadership, a certain industrial supremacy is fast becoming hers. One example will serve to illustrate the tendency to which I refer. The aniline dyes were discovered by Perkin in England about thirty-five years ago, and in that country the manufacture began. To-day, through the researches of German universities, Germany is the center of the coal-tar industry, and Engalnd has only a subordinate rank. Until recently the English universities have slighted experimental science, and English manufactures are paying for the neglect. One German firm alone, producers of coal-tar colors, employs over fourteen hundred workmen; but with them there are about fifty scientific chemists, every one a man trained in pure research, the product of the university system. These men are engaged to make investigations; to improve processes; to discover new compounds of value; and, in short, to use the most vigorous methods of science for the up-building of industry. The German manufacturer does not employ a chemist who has only learned by rote the wisdom gained by others; he does not ask to be told that which he already knows; he seeks rather to push forward into new fields; to excel his competitors more by intelligence than by brute force; and to gain a growing supremacy in preference to a mere victory for the moment. This practical policy, the outgrowth of intellectual culture, has made Germany a dangerous rival to all other countries in those departments of industry which rest upon scientific foundations. Applied science can not exist until there is the science to apply; and, where the latter is most favored, the industrial development is sure to be most perfect. This lesson is one which the United States must learn more thoroughly than heretofore, if it hopes to hold its own in the front rank of manufacturing nations. In a few of our universities the truth is already realized; but in too many American schools the so-called "practical" view prevails. Under the latter, teaching becomes routine; and the student, while learning elaborately that which is known, is not taught how to discover. He has little or no training in the art of solving unsolved problems; and that art is the mainspring of modern industrial growth. A teacher of science ought also to be an investigator, were it only for the inspiration that his example might give to the pupils in his charge. To impart knowledge is a good thing, but to reveal the sources of knowledge is better; and in that revelation is found the educational value of research regarded as a part of the teacher's essential duty.

The third agency for the advancement of investigation, the organization of scientific societies, shades imperceptibly into the other three. Private workers and university teachers here come together for purposes of co-operation, and in many countries the associations formed are aided by the state. As a rule, the great European academies are directly or indirectly patronized by the Government, and occasionally endowments are bequeathed to them by private individuals for the foundation of prizes or medals, or for the assistance of research. In our own country the societies and academies are sustained by private enterprise, but some of them hold endowments of considerable value. Partly through the latter, partly through the stimulus to effort given by awards of honor, and more largely as publishers of results, they do their greatest good, and render to science services of unmistakable value. A large proportion of the leading scientific journals are published by organized societies, and without these discovery would oftentimes be dumb.

Of government aid, the fourth great means for furthering research, little need here be said. Ostensibly such aid is given for selfish motives, since every modern government demands the help of science in return. Nowadays no government could long exist were it deprived of all the resources for defense and intercommunication which science has invented. The relation between science and the state, therefore, is a mutual relation, and each needs the assistance of the other. In Washington the fact is manifest; it is recognized in the organization of nearly every administrative department; and nowhere is it more apparent than under the Commissioner of Patents. From science the Government is daily receiving benefits; to science, therefore, it is rightly a liberal giver; and through its patronage many investigations become possible which, because of their magnitude, would be beyond the reach of private undertaking. Doubtless the time will come when the scientific resources of the national capital will be concentrated more than they are now, and so made more efficient; and sooner or later they should be crowned by the establishment of a national university, in which the highest and most productive scholarship may find a fitting home.

So far my statements have been tinged with rose-color. The great achievements of science command our admiration, and admirable also are the agencies by which it has been advanced. Still, much remains to be done, and many are the gaps in our knowledge. Take any important series of physical data, or any well-defined group of chemical compounds, bring the facts together in systematic form, and the strangest deficiencies will become manifest. Take, for example, those physical properties of the chemical elements which are capable of quantitative measurement, and not for one of them are the attainable data even approximately complete. Even iron, copper, gold, silver, and mercury are but imperfectly known. Were it not for theory, that apprehension of natural law through which science can prophesy, reaching out from the seen to the unseen, a great part of our knowledge would be little more than bare empiricism, and research itself would lack its keenest implement. It is common among ignorant men, themselves wildly speculative, to affect a contempt for theory, and yet without theory science could not exist. All great discoveries begin with theory, and lead up to wider generalizations upon which new researches find a secure foothold. The history of science teaches no more certain lesson than this.

It is easy to find a reason for the incompleteness of our knowledge. Apart from the vastness of the field to be explored, itself a sufficient excuse for ignorance, the more obvious deficiencies are due to excessive individualism in research. Thousands of earnest men are working independently, with insufficient reference to one another, each attacking that corner of the unknown which most attracts his fancy. All are ambitious to accomplish great results, each one hopes to make some discovery of signal importance; and so the drier and less attractive details of investigation are oftentimes neglected. The field is cut up into many fields, between which the ground is uncultivated, and there no harvest is gathered. To systematize research, to bring about co-operation, to put the art of discovery itself more truly upon a scientific basis, is a problem for the future. In the final solution of this problem the practical inventor may help. The wealth created by invention should serve as the organizer. The law of mechanics that action and reaction are equal and opposite, applies to human affairs as well as to physical forces. Hence, since scientific discovery makes invention possible, it is clear that the inventor owes something to science in return. That some of the harvest should go back to its source as seed is not an unreasonable expectation. Indeed, it is justified by history; and if we trace back to their origin the endowments of our universities, we shall find that the successful inventors have done their fair share. What more is needed, and on what new lines?

In the science of astronomy this question is partly answered already. Every endowed observatory is an institution for research, and outside of that the observers have little else to do. They are employed primarily to gather and discuss data, the raw material of science, and all other duties are secondary. In the solution of large problems several observatories may co-operate, each taking a definite and prescribed portion of the field; and so the science grows symmetrically, with fewer gaps than exist in other departments of knowledge. Perfection of work, completeness in the absolute sense of the term, is of course unattainable, but to that ideal within the limits of its province astronomy approaches most nearly. By its example the other sciences may profit.

Now, for chemistry and physics institutions should be organized resembling in policy the astronomical observatories. I mean, of course, endowed laboratories for research, in which the greater problems could be effectively handled, and important data determined with the highest accuracy. The more precise and at the same time the most difficultly measurable physical constants are of direct value to industrial science, and their determination should not be left to the caprice or convenience of individuals. They represent routine work of the most tedious kind; their measurement involves the highest degree of skill and the most elaborate resources, and they are the foundation-stones of exact theory. They are needed by pure and applied science alike; and yet, under existing conditions, their determination is but scantily encouraged. They yield to the investigator results more solid than brilliant; they do not give quick returns of fame; and so other researches, more showy or more profitable, are in greater favor. With most men of science, unfortunately, research is a matter secondary to other duties; the professor must teach, the commercial chemist must analyze; and only the time left over, the occasional leisure hour, is available for higher studies. Many an able man, willing and enthusiastic, who might otherwise benefit mankind by investigation, is crowded out of the field by sheer necessity. He is loaded with labors which leave no time for research, and his capacities are exhausted in mere routine. For such men opportunities should not be altogether wanting.

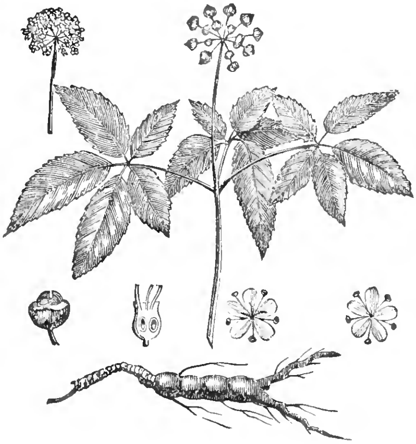
Sometimes the kind of work here indicated has been carried on at public expense; for example, the classical researches of Regnault upon gases and vapors were maintained by the French Government; but all such assistance has been sporadic, while the investigations needed should be continuous and systematic. In a laboratory endowed, equipped, and manned for research only, a rich harvest of results would be sure, far exceeding in value the cost of the undertaking. No such laboratory, I believe, now exists in the civilized world; and the United States might well have the glory of being the first organizer. In its Patent Office it has led all other nations, and in the science which underlies invention it might lead also. To the manufacturers and inventors of America I offer these suggestions, in the hope that they may be speedily realized.

GINSENG IN COMMERCE.

By J. JONES BELL, M. A.

IT is curious that, after the lapse of over a century and a half, the old Canadian industry of gathering, drying, and exporting ginseng should be revived. This root was one of the first articles exported from Canada after the Treaty of Utrecht, and for a time was considered hardly less important in commerce than fur. The revival of the industry is due to the demand for ginseng among Chinese, who have become a no inconsiderable element in the the population of the United States, whither the most, if not all, of what is now exported finds its way.

The ginseng of commerce is the fleshy root of a perennial herb, formerly called *Panax quinquefolium*, but now placed among the dicotyledonous *Araliaceæ*. The Chinese ginseng is probably derived from another species of the same genus. It is a native of the Middle and Northern States and Canada, but is found far south on the mountains. It grows in rich soil, in shaded situations, and has a fleshy root from four to nine inches long, which throws up a simple stem about a foot high, bearing at the top three long-petioled leaves, each of which has five divisions. The stem terminates in a small umbel of inconspicuous greenish-white flowers, which are succeeded by a small, berry-like red fruit. It has a peculiar and rather pleasant smell, and a sweet, somewhat pungent, aromatic taste. According to the Chinese, the root nourishes and strengthens the body, checks vomiting, removes hypochondriasis and other nervous affections, gives a vigorous tone to the system, even in old age, and is, in short, a panacea for all the ills to which flesh is heir. European and American doctors consider it almost worthless as a remedy, though it is sometimes used as a domestic medicine in the States west of the Alleghanies. *Panax fructicosus* and *Panax cochleatus*, plants somewhat akin to ginseng, are fragrant aromatics, which grow in the Moluccas, and are used by the native practitioners of India. With such unbounded faith in its beneficial effect both on body and mind, what wonder that the discovery that stores of ginseng are yet to be found in Canada should have created a demand among the Celestial population on this continent, and that the industry of digging and preparing it for market should have assumed very considerable proportions!



GINSENG (*Aralia quinquefolia*).

As already stated, the trade in ginseng is a revival of one that formerly existed. In the autumn of 1716 Père Joseph François Lafitan, a Jesuit father, who had arrived in the country in 1712, and was stationed at the Sault, above Montreal, discovered the plant. He had been in Quebec in 1715, and there saw a letter of Père Jartoux, who had seen ginseng in Tartary in 1709, and who gave a description of it. Lafitan inquired about it from the Indians, and examined the country to find it. At this time it was worth its weight in gold at Pekin. A company was formed to export it to China, Japan, and Tartary. The price at Quebec was from thirty to forty sous or cents per pound. At first any one was allowed to sell it, but as its value increased the company exercised its monopoly rights, and in 1751 undertook to exclude all others from the trade. As the demand increased, the care with which it was obtained and prepared was relaxed. It was gathered out of season, and imperfectly dried in stove-ovens. Even in this state it brought twenty-five livres per pound. In 1752 ginseng of this character to the value of five hundred thousand livres was exported. In 1754 the value of the export had fallen to thirty-three thousand livres. A quantity sent to La Rochelle remained unsold, but finally found its way to China, where its inferior quality gave the Canadian article a bad reputation; the demand fell off, and the export ceased. When the trade was at its height it was considered more profitable to gather ginseng than to cultivate the farm, and agriculture was almost entirely neglected. The result was, that the plant almost entirely disappeared. It came to be a proverb among the people, when speaking of some matter that had failed, "C'est tombé comme le ginseng." *

The revival of the trade has caused great activity in the search for the plant throughout the country back of Kingston, where it is said to abound. The profits on it are stated to be four hundred per cent, and one druggist there cleared three thousand dollars in one deal. The average wholesale price is one dollar per pound, the retail price five dollars. If the trade is to be preserved, care will have to be taken to prepare the root properly and not dig it up indiscriminately, as the root does not reach any great size in one season, but takes years to develop. In the desire to participate in the profits of the trade, some curious mistakes have been made. One man, who thought he had a rich find in Manitoba, discovered, after buying several tons, that he had not the right article. Many have confused gentian with ginseng, and, on testing the root of the former, have wondered why the Chinese were so fond of the latter.

The Chinese word *gen-seng*, and the Iroquois word *garent-oquen*, the Indian name of the plant, both mean "a man's thigh," and have doubtless been applied because of a supposed resemblance of the root to that part of the human body. This coincidence Père Lafitan could not consider fortuitous, and upon it he based an argument that America had once been joined to Asia, and that the Indian population of the former had originally come from the latter before the continents were severed at Bering Strait. The accompanying figure gives a general idea of the appearance of the plant.

Experiments were made last year by Signor Tacchini, at Rome, on the influence of passing wagons, etc., on the seismological instruments in the tower of the college, forty metres above the level of the city. The oscillations produced by the marching of a regiment of soldiers, 150 metres away, were registered by the apparatus. The result both shows the sensitiveness of the instruments and illustrates the necessity of placing geodynamic observatories as far as possible from any disturbing agencies.

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* It has gone down like ginseng.

SKETCH OF FRIEDRICH W. A. ARGELANDER.

ARGELANDER, says Prof. E. Schoenfeld, was pre-eminently an astronomical observer. In his youth he could handle every instrument as he could his pen. With his great keenness of vision, this occupation was attractive to him; but he realized that it was a means to an end. He found his life-work in collecting materials for a theory of the universe. Most of his work in Bonn was devoted to acquiring the completeness attainable under the limited capacity of the instruments in use in the knowledge of the fixed stars. To him we owe the demonstration of the proper motion of the solar system through space, and one of the fullest and most accurate of the older charts and catalogues—a work which remains a standard for reference. The materials for our sketch are derived wholly from the biography published shortly after his death by Prof. Schoenfeld, his successor at Bonn, in the Vierteljahrsschrift der astronomischen Gesellschaft.

FRIEDRICH WILHELM AUGUST ARGELANDER was born on the 22d of March, 1799, at Memel, in East Prussia, and died at Bonn, February 17, 1875. He was the son of the merchant Johann Gottfried Argelander, of descent on the father's side from Finland, while his mother was German. The relations of the family with the outer world favored the most careful training of the future astronomer. The political conditions existing during his childhood brought him early into closer relations with the great world than could have been expected to arise in the ordinary course of events in the little village so remote from the capital. The Prussian royal family had left Berlin after the unfortunate issue of the campaign of 1806, and ultimately retired to Memel. The crown prince, afterward King Friedrich Wilhelm IV, and Prince Friedrich lived in the house of Argelander's parents; and, notwithstanding the difference of three years and a half in their ages, a warm and lasting friendship was formed between the former and Argelander. Hardly less cordial was the relation of Prince Wilhelm, the late Emperor of Germany. But the times were in all other respects times of trial; and because of this the inner life was all the more richly developed. Argelander afterward attended the Gymnasium of Elbring, and, in 1813, the *Collegium Fridericianum* at Königsberg. When, in 1817, he entered the university he enrolled himself as a student in financial science, and devoted himself earnestly to it; but he soon found himself more attracted to Bessel's astronomical lectures than to all the others.

Having made sufficient advance to undertake work of that kind, he asked Bessel to intrust him with some of the calculations for the observatory. Bessel, who had then completed his Fundamenti Astronomiæ, gave him some calculations of stars not observed since Bradley that he had identified, and the problem of determining the latitude of the observatory from observation of the pole star not yet worked out. The publication of the results of these labors in the Königsberg observations introduced the author to the scientific world as Bessel's most capable pupil. Other similar calculations followed, and Argelander showed a growing devotion to practical astronomy.

The observation of an occultation of the Pleiades in August, 1820, was regarded by Argelander as his first astronomical observation; and he held a vivid recollection of its incidents in his later years. In October following he was appointed, on Bessel's nomination, assistant at the observatory. Bessel had conceived his plan for a *Durchmusterung,* or sounding of the sky, and had begun upon it, and wanted another astronomer. He employed Argelander to assist him in reading and writing down the micrometric indications on the circle. While waiting for this work to begin, Argelander made observations on setting stars, which were used by Bessel in completing his refraction tables to zenith distances 85° and 89½°, and in observing the comet of 1821. His first independently published paper, written in 1821, as a thesis for the degree of Ph. D., was on Flamstead's Astronomical Observations, and largely concerned the errors of his instruments. A memoir on the comet of 1811 was published shortly afterward. It recorded fuller observations, and covering more time, than had been made before of any comet. Relying upon Bessel's methods for the comets of 1807 and 1815, and realizing that the value of labors of the kind lay in treating the observations exhaustively, he went back to the very beginning of them. Some unexpected difficulties met in the calculations, involving among other things apparent disagreements with the law of gravitation, led him to suppose that some abnormal force worked upon the comet—a hypothesis that was not without influence on Bessel's views concerning the repulsive force of comets' tails. Although Bessel further developed these views in his work on Halley's comet, and in the controversy with Encke, respecting the resisting medium, Argelander was afterward inclined to modify his own opinions, and to hold the question open whether the movements of comets pointed to the operation of foreign forces upon them. On the faith of this paper Argelander was given a license to teach in the university.

The place of Observer at the Observatory of Åbo, Finland, having been made vacant by the death of Walbeck, Bessel was applied to to name a successor. He recommended Argelander, who was appointed in April, 1823. Argelander's journey to Finland was also his wedding tour; and he went by way of Dorpat, where he renewed his friendship with Struve, and St. Petersburg. The observatory at Åbo, newly built, was not yet fully furnished, and the nature of the observations was considerably determined by the consideration of the instruments that were available. The earlier ones were upon comets, and those made with the meridian circle; and Argelander computed the orbit of the comet of 1718 from Kirch's observations.

Attention was next given to the proper motions of the stars, the study of which, although touched upon by Bradley and resumed by Piazzi, was still in its beginning. At this time the Königsberg Observatory was extending the knowledge of the stars in mass; Dorpat, that of double stars; and Greenwich, that of stars visible to the naked eye; and Argelander devoted his observatory to the stars the yearly motion of which was given by Bradley and Piazzi as 0·2″ or more, as well as of those of which were suspected of having motions. These stars were to be observed at least four times a year, in every position of the circle.

The observations made at Åbo were published down to 1828, in three volumes, while the rest were still awaiting publication at the time of Argelander's death. The steps taken to insure the highest accuracy are fully set forth in the introduction to the second volume. The catalogue at once took a first place among the records which gave the fundamental determinations of the star places for 1830. It is also a model for convenience.

The buildings, collections, and library of the university having been destroyed by the great fire which visited Åbo in September, 1827, although the observatory was saved, it was determined to remove the whole concern to Helsingfors. Argelander was appointed a Professor in Ordinary of Astronomy in the new university, but did not remove from Åbo till 1831. Then, having visited his old home after eight years of absence and renewed his association with Bessel, he settled in Helsingfors in August, 1832, while the buildings were still in a backward condition, so that he was not able to make an observation for nearly a year, and all was not complete till September, 1835. To the Helsingfors period belong observations of the brighter circumpolar stars, of the bending of the meridian circle, and the printing of the Åbo catalogue; and the celebrated treatise on the proper motion of the solar system. Supported by the results obtained at Åbo, he found that the regularity of the stellar motions, which is explained by a movement of the sun toward the constellation Hercules, first tentatively announced by Herschel, was borne out by the observations.

In August, 1836, Argelander was invited to remove to the still young University of Bonn, where the Prussian Government had determined to erect a great astronomical institution. He found most of the labor of fitting up the observatory yet to be done. He was given, as temporary quarters, with poor provisions for his work, a bastion on the Rhine called the Old Zoll.

With irrepressible industry he composed his beautiful work, the New Uranometry, or charts of the stars visible to the naked eye in central Europe, with their true magnitudes taken immediately from the sky. Taking up the field, hitherto but little worked, of the variable stars, he adopted the methods of Herschel, improving the notation. He expressed all the differences in light by numbers, and thereby opened the possibility of investigating phenomena which no one before him had subjected to calculation. Beginning in December, 1838, with observations of Mira Ceti, he included Algol in February, 1840, β Lyræ and other stars in the summer of the same year, and, with these, telescopic stars. At the same time he tried to excite interest in the subject in other quarters, at first with limited, afterward with increasing success; and in a short time this branch of our knowledge of the fixed stars assumed a new form. The discovery in 1843 of the decrease in Algol's period led to more thorough researches on the changes of the periods and their laws. Closer examinations of the older observations were brought in, and much that had been almost lost was looked up and collected. The observations were continued for many years, and it was not till 1859 that Argelander, without giving up his interest in the work, ceased to prosecute it actively, when his eyes were becoming weak, and when the general participation of others in it had satisfied him that it would be carried on.

The New Uranometry had originated, not only in the desire to present an enumeration of the stars, to clear the charts of errors of position and designation, and to furnish observers with the naked eye with a good atlas for orientation, but also out of the conviction of the importance of leaving to posterity a good representation of the relative magnitudes of the brighter fixed stars, in order to make the real secular variations in brightness distinguishable from fancied ones. The dissertation, *De fide Uranometriæ Bayeri*, is a contribution in this direction, and has the great merit of setting out in the right light the true principles from which Bayer had allowed himself to be led in the construction of his charts. Argelander's methods of observation in this field are summarized in an essay in Schumacher's *Jahrbuch* for 1844, from which many who have interested themselves in this line have drawn their instructions. The same work contains the first general summary of our knowledge of the subject from Argelander's hand, an important revision of which is found in Humboldt's Cosmos. This treatise also bespeaks many other phenomena, of which the northern lights only is mentioned, in which Argelander had a great interest. He had made many observations on it in Finland, which he afterward published.

These accounts of special works of Argelander have caused us to anticipate much of the course of events. We return to the beginning of his life in Bonn. While still in the temporary building, having with great care obviated some of the defects of the structure, he proceeded to continue Bessel's zones to the north, from 45° to 80° declination. Thus originated the northern zones, containing 26,424 observations of nearly 22,000 stars. They were begun May 27, 1841, and were concluded as to their most important features in June, 1843, although a few gaps remained to be filled in March and April, 1844. Argelander was so busy in trying to bring them to a close that, although much interested in such bodies, he did not find time to observe the great comet of 1843 in the earlier days of its appearance.

After the completion of the new observatory in 1845, while still keeping on with the meridian observations, Argelander's attention was directed by the discoveries of new planets and comets, that were numerous in the years following, to lesser fields. The lack of exact definitions of star places south of the limits of Bessel's zones led him to the examination of the southern zones, of which he took, between May, 1849, and May, 1852, in 200 zones, 23,250 observations of more than 17,000 stars. The accuracy of these observations is somewhat unequal, but is yet sufficient for the most southern zones, and is for the brighter stars hardly less than that of Bessel's observations. The connection of the two great labors of the *Durchmusterung* was steadily kept in view. But, before the southern zones were done, Argelander had formed the plan of a still larger work. Bessel had already, when he unfolded the plan of the star charts to the Berlin Academy, contemplated the complete place-determination of all the stars to the ninth magnitude; but this had not been accomplished, even after the lapse of a quarter of a century. Argelander had tentatively finished one sheet at great expense, and begun another which he then left to others. When, on the completion of the southern observations, the materials for the charts had come into his hands again and more force was at the disposition of the observatory for other work, Argelander thought the time had come for executing Bessel's old plan. Two men were engaged at once—the astronomer at the telescope and a secretary in an adjoining lighted room to note down the time; and, to economize the time for a work of such magnitude, two pairs of observers alternated with one another. Argelander himself published a description of the methods of observation and reduction employed in the Bonn *Durchmusterung*, which resulted in the great sky-atlas and catalogue of 324,198 stars between the north pole and two degrees of south declination. Leaving the execution of these observations to his assistants, Argelander started with Struve, in June, 1852, by way of Göttingen and Berlin, to Sweden and Finland, and thence to Pultova, where he spent four weeks, to return at the end of September with the best impressions and in full vigor. The winter and spring of 1854 were so favorable to observations, while the reduction-tables were not far behind them, that Argelander could rejoice in the thought that the atlas would contain from fifty to a hundred thousand more stars than he had originally contemplated. Ever careful to preserve the unity of the whole, he arranged most of the materials himself, and was not willing to let a zone pass without personally working upon it. Double stars and stars with greater proper motions were noted; Winnecke's and Kruger's determinations of parallax were connected with these, and the restoration of lost stars from the older observations afforded ever-new interest. The revisions went on till the summer of 1861; but in some of the regions they no longer required all of Argelander's time, and he was able to pursue other objects. He identified all the stars of the eighth magnitude and brighter, which were not found in the earlier catalogues, with the accessible variable stars, the stars for comparison with the Mannheim observations of nebulæ and for former appearances of periodical comets, and especially many stars with presumed or determined proper motions. Next, while still occupied with the collation of his material, Argelander turned his eye to a work he had long contemplated, of more exact meridian observations of all the stars to the ninth magnitude, of which the *Durchmusterung* had made known the general positions. The labor, too much for a single establishment, was to be divided among different observatories. So, in the summer of 1865, he made a proposition for the simultaneous observation of selected stars at different points, by which he hoped to obtain material for the investigation of star catalogues in general, and to secure the needed number of fixed points for the greater work. The plan for this work was first presented, in 1867, to the officers of the University at Bonn, and afterward at the general meeting of the Astronomische Gesellschaft, where the author also gave his views respecting the most convenient way of carrying it out. With some slight modifications they form the basis of the programme decided upon by the society at Vienna in 1869.

Argelander undertook a small part of the preliminary work for the execution of this scheme, but found that, at the age of seventy years, he was no longer competent to make the necessary observations, and he gave them over to his assistants, carrying on himself only the minor series. The main part of the treatise on the subject was printed only a short time before his death.

Argelander was less versed in the deeper theories of astronomy than in practical work. Hence those of his lectures that had a practical bearing were most interesting, and so searching was he that, whenever he found hearers, he aroused their earnest interest. He was fond of personal intercourse with his students, and would often walk with them, conversing on various subjects, questions of the day, etc. He would go into detailed and most entertaining discussions, for which his lectures afforded neither time nor a suitable public, and he could then consider the value of conjectural hypotheses to which he was no friend. The transparency of his character, the goodness of his heart, and his open, manly bearing will never be forgotten by his friends.

His active life was not wanting in distinctions. He wore orders conferred by Russia, Prussia, Sweden, and Baden. Numerous learned societies and academies made him an active, corresponding, or honorary member; those of St. Petersburg in 1826, of Berlin in 1836, of London (not more distinctly named) in 1846, of Stockholm in the same year, of Paris and Vienna in 1851, of Berlin in 1855, of Breslau in 1856, the Royal Astronomical Society of London in 1832, the Societas Fennica at Helsingfors in 1845, and the National Academy of the United States in 1864. He received the Demidoff prize of the St. Petersburg Academy while residing at Helsingfors, and the golden medal of the Royal Astronomical Society in 1863. The jubilee of his receiving the doctor's degree was made the occasion of a grand celebration in 1872. He was almost from its foundation a member of the official board of the Astronomische Gesellschaft, and presided at the meetings in Bonn and Leipsic.

Many positions were offered to him, but he preferred to remain at Bonn, while he always preserved an affectionate recollection of Finland. He devoted himself faithfully to the interests of the observatory, but was not fond of participating in affairs of administration, and was disinclined to public life. He was a welcome guest at the social gatherings of scientific societies.

Accepting, provisionally, D'Omalius d'Halley's estimate of the population of the earth, 1,195,450,000, M. H. R. Verneau calculates that forty-two per cent of the number are of the white race, forty-four per cent of the yellow race, eleven per cent are negroes, two per cent of the mixed Oceanic races, and one per cent Indians. By local distribution, the whites occupy twenty-two per cent of the habitable surface of the globe, the yellow races twenty-eight per cent, the negroes eighteen per cent, the Oceanians three per cent, and the American Indians twenty per cent. Hence, as distributed, there are found, on equal areas inhabited by them, one Indian, nineteen negroes, twenty-one Oceanians, fifty of the yellow races, and sixty-one whites. In point of religion, 400,000,000 of the earth's inhabitants are Christian adherents of various sects.

EDITOR'S TABLE.

SCIENCE AND WEALTH.

IT is admitted on all hands that the *rôle* of science in the modern world has been a splendid and beneficent one, and that if our present civilization differs for the better in many important respects from that of any preceding age the fact is mainly due to progress in scientific knowledge. The world had greater poets in past times than any it can boast to-day—at least this is generally assumed—and greater artists and greater metaphysicians; but who would wish to go back to the age of Shakespeare, or that of Dante, or that of Phidias and Plato? We all prefer a world in which an extensive knowledge of natural law prevails, in which natural forces have been bent, as we see them bent to-day, to human uses, and in which man has decisively gained the victory over the principal destructive agencies which once were a constantly recurring menace to his life and happiness. The basis, the firm foundation, of this civilization, which, in spite of any drawbacks attaching to it, we all prize so highly, is knowledge—sifted, verified, definitely acquired knowledge of the laws of nature. The adjustments of modern life are dependent in the most absolute manner on the facilities which scientific discovery has furnished for the production and interchange of commodities and for communication between individuals. And just as knowledge advances does society as a whole assume toward its component units more and more the character of an earthly Providence. Comte spoke of it in this character fifty years ago, and, with every passing year, the term becomes more and more appropriate. "Society," says Prof. Toy, in a recent article in the International Journal of Ethics, "has come to be an efficient moral guide and support. It has worked out great ideals which have become the heritage of a small but controlling section of the race. It offers great rewards for well-doing, and inflicts terrible punishment for ill-doing. The individual is not a moral orphan in the world; society stands to him in the place of a parent, with all of a parent's power and none of a parent's weaknesses." Society, we may add, aided by science, is every day improving and beautifying the environment into which the individual is born, every day surrounding his life with new safeguards, every day bringing within his reach wider ranges of thought and increased means of enjoyment.

All this hardly admits of question; or, if a question were raised, it would probably be not as to the existence of such a general movement as we have described, but as to whether a certain section of society is not more or less cut off from its benefits. That question doubtless deserves discussion, but we are not concerned with it to-day. What we wish to point out is that, in spite of the vast benefits which natural science is daily conferring on the world, the attitude of many of its principal beneficiaries is not a friendly one. We have heard an amusing but altogether authentic tale of a very wealthy and pious lady who cautioned a friend not to have anything to do with "Christian science," not because it was a system of quackery and delusion, but because it had the word "science" in its designation. "I confess, dear," she said most earnestly, "I don't like that word 'science.'" Can such things be, amid the blaze of nineteenth-century enlightenment? Yes, they can be and are. Not often, perhaps, do we hear the *naïve* confession, "I don't like that word science"; but proofs abound that multitudes of presumably educated people, many of them living in luxury made possible only by scientific invention, dislike both the name and the thing. They dislike the exactness of science, dim as their apprehension of it may be; they dislike its methods; they dislike the standard it sets up—truth, conformity to fact, without regard to previously established opinions. The apostle of truth who preaches severe doctrine in the wilderness is not to their liking; give them one clad in soft raiment who preaches comfortable doctrine in a richly upholstered church. And how is it with the men into whose hands the practical applications of science bring measureless wealth? Do they, as a general thing, show any recognition of its importance to the world? Are they interested in aiding research? Do they determine that no one who has an impulse toward scientific discovery shall, if they can help it, lack the means of laboring in so noble a direction? Alas, no! The favorite direction for the rich man's wealth is toward the theological college. From the number and magnificence of the donations and bequests to theological colleges, in this country particularly, one would suppose that the age was starving for theological knowledge, or perchance that theology had produced the wealth that was the source of these benefactions. How the theological or denominational colleges treat science, in so far as they may adopt it as a branch of study, two or three well-known instances suffice to show—Dr. Winchell driven from the chair of Geology in Vanderbilt University; Prof. Woodrow from the chair of Natural Science at the Columbia (S. C.) Theological Seminary; and Prof. Toy, now of Harvard, from a position held by him in a similar institution at Louisville. As we write, Prof. Briggs, of this city, who, though not a student of natural science, believes in the application of scientific principles to questions of ecclesiastical history, is in danger of losing his chair at the Union Theological Seminary; while a Canadian scholar, Prof. Workman, of Victoria University (Methodist), is running a similar risk from an exactly similar cause. We have no wish to speak unkindly of theological colleges in general; some of them, as we know, are doing excellent work in certain directions; but we are strongly of opinion that bequests or donations to such colleges are not apt to advance the cause of science. That cause will no doubt gain ground more and more through the general advance of society, however much money our millionaires may devote to impeding its progress; but it might be greatly helped by judicious benefactions. A French *savant*, M. Cahours, has lately bequeathed the sum of one hundred thousand francs to the French Academy of Sciences for the purpose of assisting young men of a scientific bent of mind to pursue original researches or experiments for which they may not themselves possess the means. This we regard as one of the most hopeful ways in which wealth seeking a useful social application could be expended. Much work that would be valuable remains undone simply because the person possessing the germ-idea is unable, through lack of pecuniary resources, to develop it. Or the man with the idea puts himself in the hands of others, who, taking advantage of his poverty, make such terms as leave him with only a vestige of interest in the product of his own brain. There is room for much improvement in the attitude of men of wealth, and indeed of society at large, toward science; and, as Prof. Mendenhall showed last year in his address at Indianapolis, there is room for improvement in the attitude of men of science toward the community at large. The best fruits of science will not be reaped, and society will not undergo its great transformation, until, on both sides, the needed improvement is accomplished—until science receives the place of honor in the thoughts of all, and those who are its ministers wait on their ministering with a due sense of the sacredness of their calling.

LITERARY NOTICES.

Gospel Criticism and Historical Christianity. By the Rev. Orello Cone, D. D. Putnams. Price, $1.75.

Never before was greater interest taken in religious problems. The Bible is the storm-center of modern philosophical, scientific, and historical discussions. The questions raised are of fundamental importance. They do not affect minor details only, but the very essence of the faith. The Bible used to be considered a book *sui generis*, whose statements must not be doubted and criticised, but must be accepted without question. Now it is asked: Who wrote the Scriptures? When were they written? Are they true? Manifestly, until these questions are answered it is wholly impertinent to ask us to accept these writings as inspired authorities. Nor are we willing to take the mere word of the Church on this subject, for the Church has made so many mistakes that its guidance can not be blindly accepted. We must be given facts and reasons upon which to rest our faith, and so biblical criticism has arisen. It is a modern product—not more than a hundred years old—but, like the other modern sciences, it is most important. It does not aim to destroy religion or the Bibie, but rather to free them from superstition, and make them more credible, attractive, and influential. This is certainly the object of the book under review. Dr. Cone is well known as the President of Buchtel College, Akron, Ohio, and brings to the study of his subject a ripe scholarship, a chastened judgment, and a reverent spirit. He gives us the results of the best German criticism of the Scriptures in a most readable form. First of all, in a criticism of the text of the Gospels, he shows that "these writings were exposed to the fortune which has attended all the literary productions of ancient times; that the autographs were early lost, that the text was corrupted and interpolated; that a considerable time elapsed between their composition and the appearance of careful and accurate quotations of them, during which the changes to which the text was subjected are indeterminable; that, however, alterations, corruptions, and interpolations have not, in all probability, materially affected their essential, historical contents—that is, their accounts of the great teachings of Jesus and their representation of his life and character." One of the most important chapters is the second, which discusses the canon of the New Testament. Our author finds no evidence in the writings of the earliest Christian fathers—Clement of Rome, Barnabas, Hermas, Polycarp, Papias, Justin Martyr, and others—to justify the conclusion that the Gospels were considered by them as of exclusive authority. On the contrary, these writings, "after having remained unnamed and undistinguished in the mass of early Christian literature for about a hundred years, are found to have made their way by the beginning of the third century to a general recognition in the Church as exclusive historical sources of the life and teachings of Jesus." This conclusion is of immense importance, especially when it is remembered that the canon was not established by a careful critical examination of testimonies, but the Gospels were accepted simply on the evidence of a very uncertain tradition. In the third chapter, Dr. Cone deals with "the synoptic problem." The question is, Why do the first three Gospels contain so much matter that is *exactly* the same in all of them, while each of them, nevertheless, has much that is peculiar to itself? Several hypotheses have been framed to solve the problem: (1) It is held that the later writers copied from the earlier; (2) all drew from a common written source, or an original Gospel; (3) a fixed oral tradition was the primitive source. Our author thinks there are insuperable objections to all these theories. The eminent German critic Schleiermacher sought to explain the synoptic phenomena by the assumption of several sources, embracing only parts of the history, which were variously combined by the three writers of the Gospels. Mark and the Aramaic Logia of Jesus, which Matthew is said to have written, were among these sources. Hence our present Gospels of Matthew and Luke were largely derived from these sources. Dr. Cone adopts this view. He says: "The logia source written by Matthew and understood according to Schleiermacher's interpretation of Papias and the priority of Mark, which may be regarded as an incontestable conclusion of recent gospel criticism, furnish the key to the solution of the problem of the relation of the synoptic Gospels." Mark, according to this view, wrote his Gospel "in the last years of the sixties," probably at Rome, from notes on St. Peter's sermon, the logia by Matthew, and oral tradition. We can only partially indorse this opinion. We doubt whether Mark furnished as much of the materials of our present Gospel as our author thinks; but his view of Matthew we may safely adopt. The Logia of Jesus, which Papias says Matthew wrote in Aramaic, the Gospel of Mark, and oral tradition doubtless constituted the substrata of our present Gospel, which was written in Greek some time between A. D. 70 and 100. Dr. Cone says that the Gospel, as it now stands, contains legendary matter. "Such are probably the accounts of the birth and infancy of Jesus, the details of the temptation in the desert, the episode of Peter's walking on the water, the story of the piece of money to be found in the mouth of a fish, the rending of the veil of the temple, the resurrection of the saints at the time of the crucifixion, and the corruption of the guard placed at the tomb." The author accepts the traditional authorship of Luke's Gospel, holding that it was written by St. Paul's companion about A. D. 90. We can not subscribe to this opinion, for neither the external nor the internal evidence seems to us to justify it. Luke probably furnished the substrata of the Acts and the third Gospel (both were written by the same person), which were subsequently wrought up into their present shape by a friend of Theophilus. The prologue to this Gospel, which Dr. Cone somewhat unaccountably ascribes to the hand that composed the rest of the book, differs from it entirely in its style, and is generally believed to have been added to the Gospel by a late *redacteur*. The work is composite in its character and the product of several hands. Davidson's view of this Gospel is more satisfactory than that of Dr. Cone.

The authorship of the fourth Gospel is the *pons asinorum* of biblical criticism. The man who holds that St. John the Apostle wrote it is *ipso facto* excluded from philosophical critics, and placed among the special pleaders for traditionalism. Both the external and the internal evidences are overwhelmingly against the Johannine authorship of the book. No tradition ascribes it to the apostle for a century after he is supposed to have written it, and this late tradition is wholly untrustworthy. There is no adequate evidence to show that it was in existence before Justin Martyr's day, A. D. 140. But, above all, the style, the theology, and the general character of the Gospel make it impossible to accept it as the work of John. It is rather the mystic musing of a Philonic philosopher, who may have belonged to the Ephesian school, and have got fragments of the apostle's teaching and woven them into his work during the first quarter of the second century. Dr. Cone nowhere shows more critical ability and philosophic insight and discrimination than in his cautious yet masterful discussion of the Johannine problem. He concludes that "the problem of the authorship of the fourth Gospel is not one to be solved offhand by radical criticism, or to be pronounced upon *ex cathedra* by conservative dogmatism. If the external evidences are indecisive of its early origin (and he thinks they are); if from internal grounds we can not regard it as the work of an apostle; if it plainly has a composite character—then the unbiased critic may still be just to the ancient tradition of the Ephesian Church and to the profound spiritual sayings of the Gospel in holding that, while on any hypothesis of its origin many critical problems remain unsolved, there is at least a strong probability for a Johannine nucleus in the book, for frequent 'words of the Lord,' handed down from the apostle without connection, probably, and without a historical setting, which have in this remarkable work found a literary embodiment in the midst of much mysticism, it is true, and overlaid by Greek-Christian, second-century speculations, but distinguishable from these by their unique quality and surprising originality."

After discussing, with much clearness and satisfaction, the eschatology of the Gospels, Baur's celebrated "tendency-theory" of their composition, and the use their writers made of the Old Testament, the author considers the very important question, What is the historical *value* of the Gospels if the modern critical view of them be accepted? Are the foundations of Christianity sapped when these documents are shown to be ordinary human productions, with more or less error in them? The tyro in biblical criticism can alone take this superficial view of the case. Prof. Huxley well says, "The rule of common sense is, *prima facie*, to trust a witness in all matters in which neither his self-interest, his passions, his prejudices, nor that love of the marvelous, which is inherent to a greater or less degree in all mankind, are concerned." Any thoughtful student of the Gospels can apply this rule in separating the chaff from the grain in these writings, and Dr. Cone does it admirably. According to him, the logia by Matthew, which probably constitute the substance of the Sermon on the Mount (Matt. v–vii) and other such aphoristic sayings of Jesus, the parables, and the greater part of Mark, form the substrata of the Gospel history, and may be fully accepted. "In the midst of all the chaotic elements which the flood of oral tradition rolled along," he says, "is clearly discernible a historical grouping of salient facts—the appearance of the Baptist, the Galilean ministry of Jesus, the healings, the teachings, the travels with the disciples, the gathering multitudes, the conflicts, Cæsarea Philippi, the fateful journey to Jerusalem, Gethsemane, the trial and tragedy, the consternation of the little flock, and the mysterious birth of a great hope."

Criticism, therefore, "establishes the kernel of the history of Jesus in an inexpugnable position. It does not exclude God from history, but finds it no wonder that, since he has designs to work out in man, exceptional manifestations of his revealing spirit should betimes appear."

We consider this book one of the very best contributions which rational thought has made to biblical criticism. The style is clear and fluent, the arguments are cogent, the conclusions conservative, the spirit reverential, and the whole result reassuring. The radical critics may learn from it soberness, and the timid conservatives may find in it assurance and confidence. The book should have a wide reading among all those who are interested in the religious palingenesis now taking place in our midst.

Bulletin of the United States Fish Commission. Vol. VIII, for 1888. Marshall McDonald, Commissioner. Washington: United States Commission of Fish and Fisheries. Pp. 494, quarto.

Twelve special papers form the contents of this volume, some of them having popular and commercial interest, while the rest can be made use of only by zoölogists. The first paper reports the Explorations of the Fishing Grounds of Alaska, Washington Territory, and Oregon during 1888, by the United States Fish Commission steamer Albatross, and is compiled from the accounts of Lieutenant-Commander Z. L. Tanner, commanding the Albatross; Mr. C. H. Townsend, naturalist; and Mr. A. B. Alexander, fishery expert, of the expedition. The results of hydrographic work, dredgings, and trials for fish at a great many places are given. Codfish were found often in abundance, and halibut, flounders, black cod, and rock-fish were also taken, besides some useless as food. The paper contains also information in regard to facilities for taking and marketing fish on the Pacific coast. Three full-page illustrations show the method of drying salmon practiced by the Alaska Indians; two more show the kind of sod houses occupied by the natives; there is a distant view of three captured sealing-vessels and a near view of one of them, and others, besides three folded charts. This paper is followed by an account of Explorations of the Alleghany Region and Western Indiana, by Prof. David Starr Jordan, which we have noticed separately. Some practical Suggestions for improving Fishing Vessels, illustrated with plans, are contributed by J. W. Collins. There is an account of The Sturgeons and Sturgeon Industries of the Eastern Coast of the United States, including the making of caviare, by John A. Ryder, accompanied by twenty-three plates. Over a hundred pages are occupied by A Review of the Serranidæ, by David Starr Jordan and Carl H. Eigenman. The family of Serranidæ includes the various species of salt-water perch and bass, and other important food-fishes. Ten species are represented in the accompanying plates. An interesting chapter in the history of fish-culture is the record of several attempts at Transplanting Lobsters to the Pacific Coast, by Richard Rathbun. The volume contains also several shorter papers.

The New Religion: A Gospel of Love. By E. W. Gray. Chicago: Thorne Publishing Co. Pp 423.

The New Religion unfolded in these pages is an exposition of the doctrine of Christ that love is the law of life. The author holds that the introduction of this motive of growth differentiates the Christian faith from all antecedent beliefs. The Egyptian, Brahman, Buddhist, Greek, Roman, and Jew are spurred on by fear under inexorable law—"the gods of the old religion are not gods of sympathy and love."

In judging Christianity it must not be confounded with any parasitic "ism." Superstition must be stripped away, the dogmas of Church fathers and apostles disregarded until the teaching of Christ himself is reached. This is found to be greatly at variance with the commonly accepted notions of Christianity. "The practice of going into public for the express purpose of prayer and worship has no sanction in the New Religion," neither has a paid priesthood, nor public worship as such. The Church is overgrown with externalism which saps its life. Educational ministries are, however, productive of good, and the public meeting of the people beneficial for instruction. Another ecclesiastical excrescence is the undue value of organization. For the first two hundred years, Christians did without church or creed, "and it may well be doubted whether both the organization and the creed have helped more than they have hurt Christianity." Dr. Gray believes that Jesus was not God and man, but God-man, and his explanation of the Christ-nature is at least ingenious. He asks whether the domain of animated existence may not be extended, and suggests that, "for a specific and expressed purpose, an addition of another order of being was made." Christ was *sui generis*, a new variety. The transfiguration, resurrection, and ascension are received in their entirety as revelations of spiritual existence. The author holds that "if we accept Christianity at all, we must accept what is called the supernatural." Miracles are not contrary to the laws of Nature, but transcend them, and may be in agreement with laws still unknown.

Dogmas of later date than the creed are not gently entertained. "An instantaneous transformation of character" is "one of the chief postulates of the New Religion." This is effected not by faith, or redeeming blood, but by the compelling love of Christ. Dr. Gray points out that Christ teaches plainly a new and positive morality: "Do good to them that hate you"; "Lay not up for yourselves treasures upon earth." He insists that these directions are practical and obligatory for all Christians. Statistics are cited to show that one church controls $150,000,000 of property; another, twice this amount; and he dryly observes, "There is no scarcity . . . but the scarcity of love—the virtue of the second commandment." The author is never consciously evasive, but direct, as well as reverent in his search for truth.

The Psychology of Attention. By Th. Ribot, Professor of Comparative and Experimental Psychology at the Collége de France. The Open Court Publishing Co., Chicago. Pp. 121. Price, 75 cents.

This little work is devoted exclusively to an investigation of the mechanism of attention. The subject is divided into two distinct forms. The one, which is spontaneous and natural—the true primitive and fundamental form of attention—has been neglected by psychologists; while the other, which the author calls voluntary, is but an imitation, a result of training and education. It is derived wholly from spontaneous attention, and yet it is the only form to which psychologists have given much consideration. In this volume Prof. Ribot goes to the root of the matter in the emotional states of animals and young children; and he holds that it is only by a study of its primitive form that we can reach an intelligible explanation of the higher forms of attention.

In his chapter upon spontaneous attention, the author discusses its physical manifestations: vaso-motory phenomena, motory phenomena, or phenomena of expression; explains that its supposed effects are really its constitutive elements, that it is only the subjective aspect of the physical manifestations expressing it. He treats also of that exaggeration of spontaneous attention known as surprise or astonishment. The chapter upon voluntary attention makes up the greater portion of the volume. The study of natural attention enables him to inquire into the genesis and mechanism of voluntary attention, and to arrive at some comprehension of it. He concludes the chapter with the statement that attention in no respect resembles an independent activity; that it is bound up with perfectly determined physical conditions, that it acts only through the latter, and is dependent on the same. The last chapter treats of morbid states of attention. The name of the author is a guarantee that the work is both interesting and instructive.

A System of Inorganic Chemistry. By William Ramsay, F. R. S., Professor of Chemistry in University College, London. Philadelphia: P. Blakiston, Son & Co. Pp. 700. Price, $4.50.

The word "System" in the above title has especial significance. It indicates that the treatise to which it is applied is characterized by a methodical arrangement. Taking the periodic classification of the elements as a basis, the author has undertaken to bring into the field of inorganic chemistry an orderly arrangement similar to that which has prevailed for more than twenty years among the compounds of carbon. This, he says, owing to traditional and commercial influences, has not been done before in any book written in English. After a short historical introduction the elements are considered in order, and within a moderate compass. Next their compounds with the halogens are taken up. The author names as a defect of many previous books the ignoring of the double halides, except in a few special instances; accordingly, he has taken pains to have these compounds well represented. The oxides, sulphides, selenides, and tellurides follow next, "double oxides, such as sulphates, for example, being considered among the compounds of the simple oxides with the oxides of other elements." Other features of previous books which Prof. Ramsay has aimed to avoid are magnifying the difference and obscuring the relationship between acid hydroxides and basic hydroxides, neglecting the borides, nitrides, etc., and giving pre-eminence to methods of preparing compounds which are of commercial utility over other methods which have fully as much scientific importance. After the account of the oxides, a few chapters are occupied with the borides, carbides, and silicides, and the nitrides, phosphides, arsenides, and antimonides; and in these the organo-metallic compounds, the double compounds of ammonia, and the cyanides are considered; while a short account is given of alloys and amalgams. "The chemistry of the rare earths, which must at present be relegated to a suspense account, is treated along with spectrum analysis in a special chapter; and the systematic portion of the book concludes with an account of the periodic table." The concluding part of the volume deals with manufacturing processes, which are so grouped that substances generally manufactured under one roof are treated together. In regard to the adaptability of his system to teaching the author says: "Having used it for four years, I am perfectly satisfied with the results. For the student, memory work is lightened; for the teacher, the long, tedious description of metals and their salts is avoided; and I have found that the student's interest is retained, owing to the fact that all the 'fire-works' are not displayed at the beginning of the course, but are distributed pretty evenly throughout."

The Iron Ores of Minnesota. By N. H. Winchell (State Geologist) and H. V. Winchell. Minneapolis: The Geological and Natural History Survey of Minnesota. Pp. 430.

This extended and practical book is due to a State law directing the Geologist to make examinations and reports in regard to economic products. The first part of the volume describes the distribution and geology of the iron ores of Minnesota so far as they are known. These comprise magnetites, hematites, and some limonites. Next the methods of exploration and mining that are employed in the State are described, and accounts are given of the principal mines. There is a chapter on the facilities for transporting and marketing the Minnesota ores, another on the origin of the deposits described in the first part of the report, and a bibliography of the origin of iron ores, which occupies seventy-five pages. The volume contains also lists of mining companies and of leases of mineral lands, the mining laws of Minnesota, a glossary of mining and geological terms, etc. There are several colored plates showing microscopic sections of minerals, and other plates showing plans of mines, the general appearance of certain rocks, and the mining machinery made by various manufacturers, and there are several folded maps.

Mechanism and Personality. By Francis A. Shoup, D. D. Boston: Ginn & Co. Pp. 343. Price, $1.30.

By his sub-title the author describes this work as "an outline of philosophy in the light of the latest scientific research." Philosophy has not been so much affected by any movement in all the centuries of its history as it has by the activity of scientific thought in the last two or three generations, and this book is designed to inform the general reader as to what modification metaphysics has undergone in consequence of the scientific upheaval. "It is quite natural," says Dr. Shoup, "that they who are once taken with the experimental method should think they have no time, and show so plainly that they have no patience with the old hair-splitting, foggy metaphysic. And yet it will hardly do to cast contempt upon the old thinkers. The seductive path of positive science leads off into regions of speculative thought at numberless points; and if Science does not already know that she is caught in the toils of Metaphysics, it is only because she does not yet fully recognize her contact with the ultimate." In the early part of the volume Dr. Shoup sketches the latest results of physiological research upon the human mechanism in its relation to the psychic powers. He then devotes a chapter to the chasm between mechanism and consciousness, in which he states that the so-called scientific opinion that matter is the cause of mind is really unscientific and is not held by the leading men of science. He quotes against materialism Tyndall, Huxley, Spencer, Maudsley, Du Bois-Reymond, and Pasteur—all explicitly. Passing to the consideration of personality in its psychical aspect, Dr. Shoup treats each of the mental faculties in succession, closing with a discussion of ethical feeling, and a consideration of the infinite personality. The author states that the metaphysics of his work is in the main the Lotzian phase of Kant. The style of the book is attractive, and the author evidently has the too uncommon ability to appreciate the work of both metaphysicians and scientists.

The *Report of the State Mineralogist of California*, *William Irelan, Jr.*, for 1890, is a large octavo volume, which contains, besides the general report of the mineralogist, a large number of special reports on the several counties of the State, prepared by assistants in the field, and other special papers. Among the latter papers are an account of the asphaltum mine of Ventura Asphalt Company, by E. W. Hilgard; Lead Smelting, with figures of apparatus, by F. C. von Petersdorff; Location of Mines, by R. P. Hammond, Jr.; Quicksilver Mining, by J. B. Randol; Mining of Gold Ores in California, by J. H. Hammond; Pico Cañon Oil-fields, by Edward North; and Auriferous Beach-sands, by Dr. H. De Groot. The volume is illustrated by diagrams and photographic views, and is accompanied by six folded geological maps.

The *Annals of the New York Academy of Sciences* for November, 1890, being Numbers 9 to 12 of Vol. V, contain some two hundred pages, which are wholly devoted to Coleopterological Notices, second part, by Thomas L. Casey. A plate accompanies the text. The *Transactions* of the Academy for October, 1890, comprise the proceedings at four meetings, and abstracts of papers by Dr. John I. Northrop on The Geology of the Bahamas, by Dr. H. T. Vulté on the analysis of grains and cereals, and by Dr. H. Carrington Bolton on musical sand in the Hawaiian Islands and in California.

Volume XII of the *Transactions of the Kansas Academy of Science* covers the twenty-second and twenty-third annual meetings of the Academy. The volume contains a large number of papers, most of them brief, dealing with a wide variety of scientific topics. Among the most important are two by Prof. F. H. Snow, describing his very successful operations in disseminating contagious disease among chinch-bugs. Another useful paper, by George E. Curtis, shows the utter untrustworthiness of the weather predictions, made for a year ahead, by a local weather prophet. Some other topics treated are Artesian Wells in Kansas, Cements manufactured in Kansas, Notes on Gophers, and the Manufacture of Binding-twine.

A service has been done to persons interested in forestry by the publication of *Insects injurious to Forest and Shade Trees*, by Prof. *Alpheus S. Packard*, being the fifth report of the U. S. Entomological Commission (Department of Agriculture, Washington). The volume has 957 pages, and its contents are arranged under the names of trees. The body of the work is introduced by a chapter of general information, which includes descriptions of various insecticides, and of means for applying them to trees. The text is illustrated with 306 cuts and 40 plates, some of the latter being colored. There are separate indexes of insects, of plants, and of authors quoted.

A sketch of what has been done toward inventing a practical air-ship is given in the lecture on *Aërial Navigation*, by *O. Chanute*, C. E., reprinted from The Railroad and Engineering Journal as a pamphlet. Mr. Chanute sketches the progress in ballooning since the time of Montgolfier, and describes also the attempts that have been made to construct mechanical flying machines. He believes that dirigible balloons, which have already attained a speed of fourteen miles an hour, will before long be driven at the rate of twenty-five to thirty miles, and says that much greater speeds may, perhaps, be attained eventually with aëroplanes.

Bulletin No. 19 of the U. S. Coast and Geodetic Survey is a report by Ensign *J. C. Drake* on *The Sounds and Estuaries of Georgia*, with reference to oyster culture. It embodies an examination of all the waters under the jurisdiction of the State of Georgia in which oysters grow naturally, or in which they probably could be made to grow. The extent of each body of water is given, the character of its currents and its bottom, the area of any existing oyster-beds in it, and the density of the water. Seven large folded charts accompany the text.

The *Zoölogical Articles* contributed to the Encyclopædia Britannica by *E. Ray Lankester* have been reprinted in a volume with kindred articles by eminent specialists, which are also taken from the Encyclopædia (Scribners, $5). Dr. Lankester states, in the preface, that the purpose of the volume is to make these monographs readily accessible to university students. His own articles are those on protozoa, hydrozoa, mollusca, polyzoa, and vertebrata; the others are, Sponges, by Prof. Sollas; Planarians, by Prof. von Graff; Nemertines, by Prof. Habrecht; Rotifera, by Prof. Bourne; and Tunicata, by Prof. Herdman. These together form a treatise on a considerable section of the animal kingdom. In the reprint a few errors have been corrected, and some notes and illustrations have been added.

The *Transactions of the Iowa State Medical Society, for 1890*, contains the proceedings of the thirty-eighth annual session of the society, held in April, 1890, and a large number of papers presented at that meeting, with the discussions upon them. A subject of popular interest, treated in one of these papers, is pension examinations, the burden of the paper being a complaint that examining surgeons are required to perform several hours of professional labor for one or two dollars. The address of the president was on the question, Should persons who have inherited disease detrimental to society and the State be allowed to marry? the negative side being taken.

Johnson's comprehensive treatise on *Surveying* (Wiley), first published in 1886, has reached its seventh edition. Some changes have been made each time a new edition has appeared, and this issue contains a great many. To the part on surveying instruments have been added descriptions and cuts of the architect's level and several other instruments; the table of magnetic declination formulæ has been replaced with the new table of the U. S. Coast and Geodetic Survey; the isogonic chart of the United States has been redrawn and brought down to 1890; the chapter on land-surveying has been recast, and considerable new matter concerning monuments and the rules governing the resurvey of lands has been added; the description of the U. S. Land Surveys has been rewritten and expanded; a method of running out parallels of latitude, with suitable tables, has been added; also, tables and descriptions by which an observation for azimuth may be made on Polaris at any hour; and a description of Porro's telescope has been inserted in the chapter on topographical surveying.

In the *Report of the Smithsonian Institution, for 1889*, the secretary states that the Records of Scientific Progress in each of several branches of science, which the Institution has published for some years, have been discontinued. In place of these there will be published "memoirs of a special interest and permanent value, which have already appeared elsewhere, and which are sufficiently untechnical to be readily apprehended by readers fairly representative of the intelligent and educated class among the constituents of the members of Congress, by whom they are chiefly distributed. Among the subjects treated in such papers appended to this report are, Hertz's researches on electrical oscillations, progress of meteorology and of anthropology in 1889, national scientific institutions at Berlin, movements of the earth's crust, geographical latitude, last steps in the genealogy of man, time-keeping in Greece and Rome, the life-work of Pasteur, and memoirs of Fleischer and Kirchhoff.

An Address on behalf of the Indians has been issued by representatives of the *Religious Society of Friends* for Pennsylvania, New Jersey, and Delaware (Friends' Bookstore, Philadelphia). Its object is to show that our troubles with the Indians of late years have been due to aggressions of frontier whites upon the Indians, and to faithless and neglectful treatment by the officers of the War Department and the Indian Bureau. The address is temperate and dignified in tone, and its statements are supported by extracts from Government reports, the words of intelligent Indian chiefs, and the testimony of persons who have worked among the Indians.

A little volume of "essays against superstition" has been published by *E. C. Kenney*, under the title *Ghosts, Devils, Angels, and Sun Gods* (the author, Truxton, New York, 25 cents). He explains the origin of beliefs in supernatural beings among primitive men, and shows that many of these myths have persisted in more or less changed forms to the present day. He interprets the story of the Garden of Eden and that of the Deluge on a natural basis, draws a parallel between Gautama and Jesus Christ, and discusses the fatal number thirteen and the mystic three. The closing chapter is an arraignment of sectarian control over education. The book is temperate in tone, and is in agreement with the results of modern investigation.

For the first time in its history the *Report on Medical Education*, issued by the *Illinois State Board of Health*, embraces the medical institutions of the whole world. This is a feature that will be an assistance to medical boards that have to determine the value and validity of a medical diploma. As regards medical education in the United States, the report shows the marked changes for the better that have taken place in the past ten years, and it is seen that more progress will be made within the next two years. The report shows a marked increase in requirements as to preliminary education during the year 1890. It shows also that the movement for four years' study and three courses of lectures is an assured success, and a list is given of the colleges that have adopted or will soon adopt the requirements of longer terms of study.

Plain Talks on Electricity and Batteries, by *Horatio R. Bigelow*, M. D. (Blakiston), is a manual for physicians, describing the medical use of electricity, and the instruments and apparatus employed in this branch of therapeutics. Various forms of electrical machines, meters, and electrodes are figured, and the names of the makers are given. There are also figures showing the mode of applying electricity to various parts of the body.

A monograph on *The Modern Antipyretics* has been published by *Isaac Ott*, M. D. (E. D. Vogel, Easton, Pa.). It embraces a discussion of the nature of fever, a description of the chemical character and the physiological action of pyridin, quinolin, kairin, and thallin, a statement of the therapeutic action of each of the known antipyretics, and some observations on the value of antithermics in typhoid fever.

A pamphlet giving a brief history of

The Patent System of the United States has been published by *Levin H. Campbell* (the author, Washington, 50 cents). Mr. Campbell introduces his subject with a chapter on the early English patent system, and goes on to tell of the appearance of the system in the American colonies, and the changes in organization and practice that it has undergone in the past century.

The English Series, by *W. H. Maxwell*, has been completed by the publication of *Advanced Lessons in English Grammar* (American Book Company, 60 cents). This book is designed for a high-school or the last two years of a grammar-school course, and besides its use as a text-book it is intended to be available for reference when difficulties are met with in composition exercises, or in the critical study of literature. The first three chapters give a bird's-eye view of the parts of speech and of the construction of the English sentence. The usual divisions of English grammar are then taken up in succession. Etymology is defined as treating of the classification, inflection, and formation of words. The chapter given to the last of these topics includes lists of English, Latin, and Greek affixes, and models for word-analysis. There is a chapter on Economy of Attention, based on Herbert Spencer's Philosophy of Style, which contains certain things that can not well be placed elsewhere. The author is Superintendent of Public Instruction in Brooklyn.

The method adopted by *David Salmon*, the author of *Longman's Primary-School Grammar* (Longman's, 35 cents), is that of "making children familiar first with the thing, then with the name." Accordingly, the child is first required to pick out all names of persons in a given series of sentences, and the other requirements of the first exercise are: "Give the names of ten boys; ten girls; ten persons whom you know; ten persons about whom you have read." After ten similar exercises on nouns of different sorts the first definition is given to be learned. The author says that he has made his definitions so that young children can understand them, although in doing so he has made some of them unsatisfactory to a logician.

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Adams, Charles F., Worcester, Mass. Examination Questions for Normal Schools. Pp. 42.

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POPULAR MISCELLANY.

Spontaneous Languages.—We noticed, several months ago, a deeply interesting study of the spontaneous development of language in children, by the Hon. Horatio Hale. The same phenomenon—tantamount to the creation of an original tongue—has been observed by other persons; among them, Miss Watson, of Boston; Dr. E. R. Hun, of Albany; Archdeacon Farrar (in the case of Indian children left by themselves for weeks together in Canadian villages); and by M. Taine, in his work *De l'Intelligence.* Mr. W. J. Stillman has recently communicated to Nature observations made by him upon his son several years ago, when he was under the care of an Italian nurse. As the child's utterances took shape it was found that he repeated certain sounds with a definite meaning, and soon coined a small vocabulary for himself, comprising words for bread, water, milk, etc. The first word distinguished was *chumbhoo*, for water. Then in a few weeks he began to couple the Italian words with his, and said *chumboo-aqua.* Little by little he dropped his own words and began speaking only Italian. Recently, when on a visit to Crete, Mr. Stillman met a boy who had formed for himself a similar language, with the same word for water as his own son had invented. Mrs. Agnes Crane cites in a later number of Nature the case of a nephew of Dr. George Gablentz, a well-known Sinologist, who, before he learned his mother-tongue, called things by names of his own invention. The constant elements were the consonants, while the vowels were varied and employed as they were deeper or higher to denote greatness or smallness. The root for round objects was *m—m*; a watch, plate, and the moon were *mem*, a large round dish or table was *mum*, and the stars were *mim mim mim*; an ordinary chair was *lakail*, a great arm-chair *lukull*, and a little doll's chair *likill.* The Rev. J. C. Ball, a distinguished philologist, and his young brother, when six or eight years old, had names of their own devising for their tools and toys. Mary Howitt's elder sister, Anna, did not learn to talk till she was four years old; and even then, having but few words, the children had to coin their own. To sneeze was *okis-how*—a sound, she thinks, one of their parents must have made in sneezing. By a similar onomatopœia, an American child called cat *mea*; in another child's vocabulary, the extraordinary trisyllable *shindikik* designated that animal. The association of ideas and extension of meaning are often very suggestive—viz., *migno-migno*—water, wash, bath; *waia waiar*—black, darkness, negro. It is interesting, Mrs. Crane adds, to note the continued use of Mr. Stillman's boy's own name for water as a means of identifying the acquired Italian *aqua* for the same object, as frequently happens with adults struggling to express themselves in a foreign tongue. Reduplication seems also to characterize these child-languages like those of some savage tribes, and plurals are formed by repetition.

Botany in the Harvard Museum.—The provisions for the permanent display of the botanical section of the Harvard University Museum are nearly complete, and will be unusually comprehensive. The exhibition is planned to contain both dry and alcoholic preparations, representing nearly all the botanical regions. The genera of North America will be most completely illustrated, while the principal groups from other parts of the world will be properly related to them in accordance with an educational plan. The illustration of the economic plants of this country will be extended through all the stages of development, and will be a prominent feature. A unique feature in the department of imitative specimens will be the collection of glass models, which have been prepared after a secret method by Herr Blaschka. They exhibit the whole microscopic structure with the different phases of growth accurately in details, and in some cases very largely magnified. The collection has also been given a set of duplicates from Columbia College representing the South American collection of Dr. Morony. The exhibition-rooms will be connected by passage-ways with those of the Zoölogical Museum on one side and the mineralogical section on the other side, and this in turn will be connected with the proposed corner-piece extending to the Peabody Museum; so that there will be a quadrangle with an unbroken circuit through those parts of the University Museum which are planned for public exhi bition.

Resources of Honduras.—Mr. W. Pilcher gave to the British Association the results of his observations in Honduras during three months when he traveled on mule-back over a thousand miles, chiefly through that part of the country lying on the Pacific slope of the Cordilleras. On the Guayape and Jalun Rivers, in Olancho, the gold-washing provides an easy living for the natives. At the old Spanish mines of Opoteca and Yuscaran the mining camps of the Americans and Germans are at full work. Tropical vegetation abounds in the beautiful and fertile valleys and plateaus, and coffee, rice, maize, sugar-cane, bananas, plantains, guavas, oranges, lemons, and other fruits are continuously produced without fear of frost or adverse seasons. Herds of cattle and native horses are scattered over the country, and Honduras, with its natural advantages and its proximity to New Orleans, presents good opportunities to the foreign settler for the successful employment of his capital in the raising of cattle and the production of the fruits of the country.

Prof. Brooks's Studies in Oyster-culture.—Prof. H. Newell Martin refers the beginning of the scientific culture of the oyster to a paper by Prof. Brooks, which appeared in the first number of the Studies from the Biological Laboratory of Johns Hopkins University, "On the Development from the Eggs of a Certain Mollusk." It was followed in the next year by a treatise on the development of some fresh-water mollusca; and during the same year another member of the university endeavored, at the instigation of the Fish Commission, to discover the young oysters and learn their mode of life. The first effort failed, because the young oyster was looked for between the shells of its mother, where it was not. Then, in 1879, Prof. Brooks undertook the search on the invitation of the Fish Commissioner for Maryland. Within twenty-four hours of his arrival at Crisfield, he discovered that the American oyster is not nursed within the shell of the parent, but shows an early independence; and that it is possible to take their eggs from oysters and fertilize and rear them artificially, as is done with the eggs of shad and trout. "These two discoveries, based on previous investigation of the development of mollusks which have no commercial importance, made a new starting-point for the study of the oyster. It was impossible to catch and study in continuous development the microscopic, embryonic oysters scattered throughout the Chesapeake Bay; but, once we could hatch the oyster in the laboratory and study its growth and life conditions, a very important step forward would be made. It was proved that we could get young oysters in incalculable numbers at a very small cost, and, far more important, an opportunity to investigate the life conditions of the young oyster would be given. To carry on the growth of the artificially hatched young oysters a steady supply of fresh sea-water was needed. This the university provided the next year by the purchase of a small steam-engine and a complete outfit for the breeding of young oysters on a small scale." Before the party left Crisfield, in July, 1879, they had established the two leading facts that the eggs of the Maryland oyster are thrown out into the bay to be fertilized at random, and that it is possible to fertilize and hatch thousands of them in a watch-glass; in fact, that in a few buckets of sea-water one could hatch enough eggs to supply spat for the whole Chesapeake Bay.

Building Homes.—A beaver in captivity, says Chambers's Journal, will build a dam across the kitchen, making it of sticks and brushes, with a charming air of doing the best he can. The nest-building of birds has also a delightful air of contrivance about it. One likes them for the marvels they do with bits of grass and rag and wool. There is human nest-building too; but, considering their resources, the birds are before us in the beauty and utility of their work; while in contrivance the beaver in the story leaves us nowhere. Our house-building corresponds to the nest-building of the birds. It is the preparation of our home: utility and beauty are to be as guiding lines in arranging our plan. Let it be remembered that we are not contriving a furniture mart or a *bric-à-brac* shop, or even a place on view, but a house to be lived in, every room and part of which is to be made enjoyable. It is greatly a matter of common sense and good taste; these produce better results than the check-book and the complete house-furnisher. The moneyed system results in a mansion complete, from a grand piano down to a cat and a duster. The system of contrivance boasts of having secured all one likes best, and all in good taste. The planners and contrivers are the true nest-builders. After duly considering the whole matter, the writer concludes that "our hints resolve themselves into two principles: arrange the house not by rule or custom, but for the use of each room; and let beauty unite with use in every part."

The Massachusetts Institute of Technology.—The history of the Massachusetts Institute of Technology is traced by Mr. Augustus Lowell in a commemorative address on the occasion of its twenty-fifth anniversary, June 3, 1890. It was opened in 1865, under the direction of Prof. W. B. Rogers, with twenty-seven students; it has now, after having suffered a decline in the years following the financial crisis of 1872, more than nine hundred students. A laboratory of general chemistry was introduced almost at the outset. The Rogers Laboratory of Physics, where the student could make observations and conduct measurements for himself, followed soon afterward. In 1871–'72 a scientific expedition of students and instructors went to the Rocky Mountains, and brought back with them from California apparatus for a laboratory of mining and metallurgy—the first proper concern of the kind devoted to purposes of instruction in the world. A laboratory of steam engineering was established in 1873, a system of shop-work in 1876, a laboratory of applied mechanics in 1881, the germ of a biological laboratory was introduced in 1884, and a laboratory for a course of electrical engineering was instituted in 1883. The last study is treated as dependent on mechanical engineering, and the recognition of laboratory work in mechanics as an essential feature of a proper training in any branch of the engineering profession is considered the last contribution of the Institute to the philosophy of scientific and technical education.

Petroleum Fuels.—Petroleum is defined by Prof. William Robinson as, in the widest sense of the term, comprising not only the mineral oils found in the earth's crust, but also the oils obtained by the destructive distillation of coal and bituminous shale. These complex liquid hydrocarbons vary in appearance from that of clear, light kerosene oils to heavy, dark-greenish slush or semifluid slime. After the volatile or lighter oils have been driven off from crude petroleum, the heavy oil left is known as *residuum* in America; in Russia it is called *astatki*. This *astatki*, or heavy petroleum refuse, is an excellent liquid fuel, and is at least twice as good as ordinary coal for steam-raising purposes. The light lubricating oils, intermediate oils, and kerosene or ordinary lamp oils are all being used at the present time instead of coal-gas in the cylinder of the internal-combustion engine. In some cases the heavier oils are converted into an oil-gas, which, when cooled, is admirably adapted to drive gas-engines. Other internal-combustion engines, as, for instance, the Priestman, Akroyd, and Knight engines, use common burning oils directly, and act as their own gas generators. Prof. Robinson urges that such dangerous and highly volatile hydrocarbons as benzoline, gasoline, and petroleum spirit should not be used as fuel in gas-engines. The long series of accidents so frequently attending the use of these light, inflammable vapors have done more than any other one thing to retard the development of this class of prime motors, by prejudicing the public mind against the appearance of oil in any shape or form. This volatile spirit may, however, act with safety as an evaporating agent instead of steam, as in the Yarrow spirit launches, where it is used in the internal parts, and provision is made against leakage, while ordinary burning oil generates the heat. It will thus be seen that liquid hydrocarbons, such as common petroleum oil, may be employed in prime motors as a substitute for either coal or steam or both. It is becoming generally recognized that for large powers, notwithstanding some advantages, the ordinary vaporizers in petroleum oil-engines are difficult and troublesome to work with. In fact, for large engines the practical plan obviously is to convert oil into gas by means of a gas-producer. Oil-gas, when cooled, can be used with great economy in the engine cylinder. Further, a very decided saving of fuel may be effected by this combination of oil-gas producer with the internal-combustion engine, in place of the boiler and steam-engine, in many places where suitable oil is cheap or plentiful, or where intermittent work is required. On the other hand, more heat may be produced by the direct combustion of liquid fuel with dry steam and air than by converting the oil into gas before using it as a fuel. Oil-gas is a safe, rich, permanent gas made from petroleum oil, and burned with excellent results in the gas-engine cylinder.

Improved Ventilation. — According to Mr. D. G. Hoey, the first attempt to apply really scientific principles to ventilation was made by Sir Humphry Davy in 1811, and nothing better has yet been offered. Davy proposed to ventilate the House of Commons by admitting fresh air through numerous holes in the floor and carrying off the foul air by tubes in the ceiling leading directly without, heated to promote rapidity of discharge, while the doors and windows were kept closed. The scheme failed in practical application because of defects in mechanism. A method based upon the same principles is proposed by Mr. Hoey, and has been applied in certain buildings in Glasgow. In it, for the admission of the fresh air without currents or draughts, a dado, about three feet high, is fitted at conveniently available parts around the room, with a narrow space between it and the wall. On the top of it wire gauze or perforated metal is fixed in an inclined position (to keep things from being put upon it). The fresh air is introduced into the dado space at a low level and in a lateral direction to promote diffusion, through a number of inlets from the outer atmosphere along the whole line. The total area of these inlets is proportioned to the area of the hot-air shaft provided for carrying off the impure air. The total space inclosed by the dados is much greater than the total area of the inlets from the outer atmosphere; and by this means the entering air is made to spread itself slowly through the interior of the reservoir, and to percolate gently through the gauzes so as to permeate the atmosphere of the room by gentle diffusion, instead of entering in a stream. In winter the air admitted may be warmed by a heating surface of pipes fitted along the length of the dado. For carrying off the impure air, a chimney of suitable capacity is provided, with a close-throated fire grate; or a connection is formed with any existing perpendicular flue. There should be an opening in the room, at a high level, into an outlet tube communicating with the perpendicular column of rarefied air in the chimney or flue. When a suitable chimney or upright flue is not available, the same results are produced by a suitable tube erected above a skylight in the roof of the hall, in which a current may also be promoted by means of a Bunsen burner.

Labor as a Means of Human Improvement.—The remark which has been a long time current is re-enforced by the latest studies, that the prevailing and dominant people, races, or nations, and the flow of superior human energy have always come from the cold, bleak, inhospitable regions of the north. Notwithstanding physiology indicates a tropical or subtropical origin for mankind, man in the tropical regions makes no advance, but tends, on the whole, to decline; and when men from the temperate zone settle in tropical regions, they are very liable to become enervated. The probable reason for this tendency is that living in such regions is too easy, and that the conditions prevailing there do not afford the stimulus to the exertion without which it is impossible to keep up vigor. So, when, anywhere, a hard-working, active people meet with fortune and settle into a life of ease, they begin at once to weaken. In England, it is the common people who are multiplying rapidly and swarming all over the earth; while the aristocracy can not even keep up its stock, but has to be refreshed from time to time by the interpolation of fresh blood. These facts are used by Prof. Williams to enforce the maxim that every human being should earn his daily bread by daily work, and that the inheritance of such an amount of wealth as shall render a man or a woman a mere purposeless pleasure-seeker is a most degrading curse.

Aniline Photographs.—Analogous to the photographic process with the salts of silver is the production of pictures by a similar process with the aniline colors. As described by Messrs. Green, Cross, and Bevan, in the Society of Arts, the simplest method of producing a picture in any of these colors is based upon the fact that they all fade more or less on exposure to sunlight. Prints obtained by exposure to sunlight of paper coated with eosine and methylene blue were exhibited by the authors, in which the gradations of shade were exactly reproduced; those parts which received the most light were the most bleached, whereas the shadows of the object had protected the parts of the paper beneath them, and the depth of the shadow of the original was thereby reproduced. These pictures have no practical value, because they are destined to be obliterated by the gradual fading out of the whole surface. In the diazotype process, the picture is fixed by causing a compound to be formed which will resist the further action of the light. The process starts with the yellow body called primuline—a substance constituted with ammonia, having one of the hydrogen atoms replaced by a complex group. It combines with nitrous acid to form a diazo compound, and this, like the other diazo derivatives, exercises a constructive or synthetic reaction with the amines and phenols, with which azo-coloring matters are formed. The essential conditions of primuline photography are that the reactions take place with primuline after its application to any surface or material as a dye, without affecting its union with the material; and that the diazo derivative produces the photo-sensitive in the highest degree. The prints obtained are positive, the light and shadow of the object being exactly reproduced in the colored picture. Natural objects, therefore, of convenient form, such as leaves, may be photographed directly; reproductions from camera pictures require glass positives, or positive paper prints made transparent in the usual way with vaseline. A second process is based upon the peculiar properties of the diazo derivatives of the coal-tar bases, in which the light plays a constructive part in the development of a colored picture. When the diazo compounds are treated with an alkaline bisulphite, they are converted into the diazo sulphonates, on which the action of light is to set free the diazo group from its combinations, but which do not react with phenols and amines. The mixture of a diazo sulphonate with the latter is unattended by any color reaction; but, on exposure to light, the diazo group being set free in presence of a phenol, the development of an azo-color takes place with equal step. In the process based on this reaction, the photographic surface is a mixture of a diazo sulphonate with the alkali compound of a phenol applied to any suitable material. On exposure to light under a transparency, development of color takes place in proportion to the quantity of light transmitted, giving, therefore, a reversed reproduction, or negative picture. When printed, the unattacked mixture is dissolved away by copious washing, and leaves the picture, already developed in the azo-color, which is relatively insoluble, permanently fixed upon the fabric or material. The primuline process is simple. It can be practiced with the minimum of apparatus, requires no technical training, and the results are striking and pleasing.

Processes for sterilizing Milk.—The report of Messrs. W. T. Sedgwick and John L. Batchelder, Jr., concerning the milk-supply of Boston, shows that milk drawn directly from the healthy cow is ordinarily free from bacteria, or sterile. It is, however, so rapidly contaminated in the act of milking, and is itself so favorable a medium for the growth of bacteria, that even "pure country" milk contains hundreds of bacteria per teaspoonful. The time required before this can be distributed in the city is so great that milk arriving by rail in Boston contains about 300,000 per teaspoonful, while that taken from wagons or sold in groceries is older and shows from one to ten millions. Mrs. Ellen H. Richards and Mrs. Mary Hinman Abel, who have made an especial investigation of the subject for Mr. Edward Atkinson, find the conclusions forced upon them that a large percentage of milk in daily use is liable to contain disease germs which may under favorable circumstances be communicated to the consumer; and that even healthy milk is a highly putrescible substance, which in its raw state offers a most favorable medium for the culture of many kinds of bacteria that grow in numbers and rapidity, depending principally on the surrounding temperature, and that in the digestive tract, especially of young children, in warm weather this partly decomposed milk leads often to fatal results. Various chemicals have been used to neutralize the acids resulting from the activity of these bacteria, but they have one and all been condemned as injuring the milk or as deleterious to the stomach. It is at present agreed on all hands that only by the application of heat can all this germ life be destroyed and the milk made safe without injuring its food value; and numberless experiments have been made to determine how high a degree of heat must be employed and how long it must be continued. This process is known as sterilization. By the ordinary methods in use considerable changes are wrought in the milk by sterilization; and means have been sought to destroy the bacteria, if possible, at a temperature that would leave the milk unchanged in odor, taste, and appearance. Several processes for this purpose are mentioned in Mr. Atkinson's paper; and it has been found that the object is accomplished by restricting the temperature to 140° Fahr.

Observatory Work at Harvard.—The Director of the Astronomical Observatory of Harvard College calls attention in his annual report to the need of a fire-proof building for the storage of photographic plates. The observatory has received in the last year about nine thousand such plates—some taken in Peru, some in California, and some in Cambridge, and it has in all about twenty-seven thousand of them. They represent the entire sky from the north to the south pole, the greater portion of it being covered several times; and they show the spectra as well as the positions of the stars. A large part of the charts and nearly all the spectra are unique, not having been photographed elsewhere. Much time has been devoted at the three stations of the observatory to visual observations of the colors and markings of the planet Mars. A number of the so-called canals were recognized, but only one of them was seen to be double. The best means of photographic enlargement of astronomical observations have been studied. Investigations have been conducted with regard to the meteorology of the globe, with particular reference to cloudiness and other phenomena affecting the choice of astronomical stations; the fundamental principles of astronomical photography; the great nebulous region of Orion; the best form of standard light, and other details of quantitative photographic work.

Extension of the English Coal-fields.—A discovery of coal has been made near Dover which promises to mark a new era in the industrial development of England. It is full of interest, not only from the commercial point of view, but also, as Prof. Boyd Dawkins, who had much to do with it, remarks, because it is the story of a scientific idea originated many years ago, taking root in the minds of geologists, developed into theory, and ultimately verified by facts. The physical identity of the coal-bearing districts of Somerset on the west with those of northern France and Belgium on the east was recognized by Buckland and Conybeare, as far back as 1826, as well as the fact that the coal-measures lie buried partially under the newer rocks. Twenty-nine years later, Mr. Godwin Austen read a paper before the Geological Society of London on the possible extension of the coal-measures beneath the southeastern part of England, in which he set forth the facts in the geological structure of the country; whence he drew the conclusion that there are coal-fields beneath the Oölitic and Cretaceous rocks in the south of England, and that they are near enough to the surface along a certain line to be capable of being worked. He mentioned the Thames Valley and the Weald of Kent and Sussex as possible places where they might be discovered. An inquiry was made between 1866 and 1871 under an official commission, before which Godwin Austen testified. The report of this commission, drawn up by Prof. Prestwich, gave the evidence for and against the existence of the alleged coal-fields. The views of Godwin Austen were fortified by a large series of observations; and the conclusions were reached that coal-fields of the same kind and value as those of Somerset and of northern France and Belgium exist under the newer rocks of the south of England, and that the same measures which disappear in the west under the newer rocks of Somerset reappear in the east from underneath the newer rocks of the Continent. The Sub-Wealden Exploration Committee bored for this coal at Netherfield, from 1871 till 1875, to a depth of 1,905 feet without finding encouragement to go further. In 1886 new borings were begun at Dover. They have been carried on till the present time, to the depth of 1,224 feet. The coal-measures were struck at a depth of 1,204 feet from the surface, and a seam of good blazing coal was met with twenty feet lower. This discovery, Prof. Dawkins says, "establishes the fact that, at a depth of about 1,204 feet from the surface, there is a coal-field lying buried under the newer deposits of southeastern England, and proves up to the hilt the truth of Godwin Austen's hypothesis after a lapse of thirty-five years. The question is finally settled so far as the purely geological and scientific side of it goes." The commercial value of the discovery is next to be estimated. A favorable prognostic is derived from the richness of the corresponding beds on the Continent. The depth is not too great for profitable working, for most of the important coal-pits in England are worked to a greater depth than this, and range to more than 2,800 feet; and one pit at Charleroi in Belgium is worked to a depth of 3,412 feet.

Permanent Value of the High-altitude Cure.—The acclimation of consumptives to the climate of Colorado, and the return of cured patients from high altitudes, were discussed at last year's meeting of the American Climatological Association, in Pueblo, Col. Dr. H. O. Dodge regarded the acclimation of the individual as consisting in overcoming the conditions of altitude and low density of atmosphere that prevail in mountain regions, and in acquiring the ability to do full labor or take continuous exercise without detriment to the system. The diminished heat at the high altitude, together with the increased tissue-changes consequent on the accelerated circulation and respiration, create an increased demand for food; hence the Coloradan mountaineer is blessed with a keen appetite and vigorous digestion, and, while his store of adipose is usually small, his muscular powers are, as a rule, high. The cool nights promote refreshing sleep, and the dry atmosphere enables one to withstand without inconvenience changes of temperature that in more humid regions would be detrimental or dangerous. The aggregate of persons who become acclimated in Colorado and thereby cured may be divided into three classes, viz.: first, a few who are absolutely cured and who may go to any part of the world or engage in any business, and enjoy an immunity from consumption; those who may go to lower and less favorable climates during certain selected seasons; and those who can not with safety make any change of climate. According to Dr. Dodge's observation and recollection, the first class includes about nine per cent of the patients; the second class, including the first, about fifty per cent; and the third class about fifty per cent. Concerning the safety of a return from the high altitudes after having enjoyed an arrest of the disease, Dr. Frederick I. Knight, of Boston, thought that those who show a strong hereditary tendency to the disease had better be encouraged to remain in the climate where the arrest has taken place. But a patient who has no inherent tendency to this form of disease in himself, but has been the victim, as it were, of external circumstances, may be allowed to try a return under different conditions.

Science at McGill University.—During the past year McGill University, Montreal, has received gifts from citizens of that city aggregating one million dollars, one half of which sum has been given by Mr. William C. McDonald. The larger part of the donations is being expended by the Faculty of Applied Science, of which Prof. H. C. Bovey is dean. A group of new buildings, to accommodate classes in civil, mining, mechanical, and electrical engineering and practical chemistry, will be completed for the reception of students in September. A large additional building for instruction in physics will be in readiness early next year. The laboratories in the engineering departments are provided with the latest and best appliances, including a hundred-ton Wicksteed and a seventy-five-ton Emery machine for strength-testing, a one-ton Faïja spring-tester for cements, a high-speed steam-engine coupled direct to a dynamo for incandescent lighting, and two Thomson electric balances. The museum will contain the Reuleaux collection of kinematic models, the most complete in America. The workshops are fully equipped with machinery of the best and most modern type. Students will be trained in carpentry, turning, pattern-making, smith-work, molding and casting, and in machine tool-work. In the details of buildings, appointments, and curriculum the faculty has endeavored to profit by the examples of the best technical colleges of the United States; in some respects it has succeeded in taking a stride ahead.

The Central Group of the Caucasus.—The central group of the Caucasus Mountains is thus described by Mr. Douglas W. Freshfield: "Elbruz and Kasbek stand some one hundred and twenty miles apart, the former due north of the easternmost bay of the Black Sea, on the edge of the Scythian steppe, the latter in the center of the isthmus overhanging the Dariel road. About midway between these ancient volcanoes the Caucasus culminates in grandeur, in extent of glaciers, and (setting aside Elbruz) in height, in a cluster of magnificent granite peaks and ridges, inclosing great firths of ice which roll gently into the northern valleys, or pour down southward in frozen cataracts till they touch the forests of Suanetia, where they end at an average elevation of seven thousand feet. The snow-level varies between nine thousand five hundred and eleven thousand feet, according to the nature of the soil, the level, and the exposure. Of the peaks, two exceed seventeen thousand feet, and five sixteen thousand feet, while another is higher than Mont Blanc. The longest glacier, the Bezingi Glacier, is ten miles in length—longer than any glacier in the Alps except the Aletsch."

Force of Mushroom Growth.—Dr. A. S. Hudson informs us that several mushrooms have been found growing in the concrete floor of a livery stable in Stockton, Cal. The floor had been laid a little over a year, and consisted of a layer of cement, three or four inches thick, with a top coating of asphalt and gravel. The mushrooms had started in the concrete; one specimen that was examined came from an inch and a quarter below the surface, and had broken through the cement above this point. It grew to about an inch and a half in height, and its stem was three fourths of an inch thick. The mushroom was white, and its texture was as firm as that of a turnip. Where another one had broken through, the fragment of cement forced up was found a foot away. The most probable way of accounting for the presence of the fungi in this very unfavorable situation is that the spawn became mixed with the cement when the floor was laid.

NOTES.

The Royal Society of Canada met in Montreal, May 27th to June 1st, Principal Grant, of Queen's College, Kingston, presiding. The society was founded by Lord Lorne in 1881, on the lines of the Royal Society of England, combining, however, literary with its scientific sections. Sixty-three papers were read, several of them of high interest. Reports were presented by a score of societies scattered throughout the Dominion, each at work on some branch of natural science, historical research, or literary production. Several delegates from the United States were cordially welcomed; General F. A. Walker, Vice President of the National Academy of Sciences, representing that body, and Major J. W. Powell, Director of the United States Geological Survey, the learned societies at the national capital.

A new arctic expedition has been fitted out at this port, and sailed hence on the 6th of June. It is called the Peary Expedition, from Lieutenant Peary, its commander, and its object is the determination of the northern limit of Greenland, which its leader hopes to reach about the middle of July, 1892.

The third meeting of the Australasian Association was held in Christchurch, New Zealand, beginning January 15th. Sir James Hector presided. The American Association was represented by Prof. Goodale, of Harvard University, but no representative of the British Association was present. Recommendations were adopted that the sea between Australia and New Zealand be named the Tasman Sea; asking the appointment of a committee by the British and American Associations to define terms of general importance in biology; and that the Little Barrier Island, north of New Zealand, and Resolution Island, on Dusky Sound, be set apart as reserves, where the native fauna and flora of New Zealand may be preserved from destruction. The next meeting of the Association will be held at Hobart, Tasmania, with Sir Robert Hamilton as president.

Discrepancies in the names or in the spelling of them occurring in the surveys of the different departments of the national administration, and the absence of any authority on the subject, have prompted the organization of the United States Board of Geographic Names. Questions which are brought before this board are submitted to its executive committee, which examines the matter, consults authorities, and uses whatever assistance may be available. It then reports to the board, which decides the matter by vote. The first bulletin of the board relates to names in Alaska. The co-operation of all geographers, historians, and other scholars interested in geographical nomenclature is invited in its work.

While local farmers and butchers in the United States are pretending to adduce sanitary reasons for discouraging the use of meat that comes in refrigerating apparatus from a distance, the Lancet uses them in support of the transportation of all meat to the market in that way instead of bringing the cattle alive. It assumes that it would be much fairer to consumers to interdict the importation of living animals as food, and to insist upon receiving carcasses only. This would certainly lead to the abolition of the hardships and sufferings the poor brutes now undergo, would insure better meat, and would avert the introduction of contagious diseases which have already impoverished British agriculture, and which require the maintenance of an expensive system of inspection at ports all round the coast of the country. "The middle-man might perhaps complain; but as he is, so far as we can see, the only one who profits from this stupid and cruel business, we need not consider him in the matter."

Mr. Stanley, in his Darkest Africa, gives Emin Pasha as authority for the statement that the chimpanzees, which visit the plantations of Mswa station at night to steal the fruit, use torches to light the way. "Had I not witnessed this extraordinary spectacle personally," said Emin, "I should never have credited that any of the simians understood the art of making fire. One of these same chimpanzees stole a native drum from the station, and went away pounding merrily on it. They evidently delight in that drum, for I have frequently heard them rattling away at it in the silence of the night."

An International Colonial Exhibition is projected to be held next year in Paris. A peculiar feature will be the geographical rather than political character of the grouping of the sections. Thus, all the West will form one section, India another, and so on. Specimens of all the native populations are to be brought over and housed as at their homes—as is habitually done at the *Jardin d'Acclimatation*; and colonial and ethnographical congresses are to be held.

The objection to cremation that it facilitates poisoning by diminishing the probabilities of detection, was dealt with by M. Frédéric Passy, at a recent meeting of the French Cremation Society. The speaker urged that vegetable poisons vanish rapidly, and, if mineral poisons are used, most of them can be detected in the ashes. Moreover, there are poisons the presence of which in a human body does not prove that a crime has been committed; and, if cremation is generally adopted, greater care will be taken to determine the precise causes of death.

Lake Urumiah, in Persia, 4,100 feet above the sea, is, according to British Consul-General Stewart at Tabriz, the saltest body of water on the earth, being salter than even the Dead Sea. It is eighty-seven miles long and twenty-four miles broad, and contains nearly twenty-two per cent of salt. Its northern coasts are incrusted with a border of salt glistening white in the sun. It is said that no living thing can survive in it, but a small species of jelly-fish manages to maintain an existence in its waters.

According to Mr. Joseph Jibrail, who has been a teacher among them, the most curious beliefs of the Druses are those connected with China, which they regard as a holy land, where they will be reborn when they die. Eclipses are supposed to be caused by a dragon eating a piece of the sun or moon. Some of their beliefs recall those of the early Gnostic and Manichæan sects in Syria.

A curious example of the natural "inarching" of trees exists in Lawrence County, Ill. The trunks of two elm trees, standing about twenty feet apart, have met at about the same distance above the ground, where they blend into a symmetrical trunk of large dimensions. The tree is nearly a hundred feet high, and well developed; and wagons can easily be driven through the great triangle which forms their base.

Mr. Merrifield, a British officer in Tenasserim, says that the belief that the teeth of the Malays and Siamese are colored by chewing betel mixed with lime is an error. The black color is produced by a special process employed for the purpose, for no respectable Siamese would like to have white dogs' teeth like Chinese, Indians, and Europeans. Cocoanut kernel is carefully charred, and then worked to a stiff paste with cocoanut oil. When carefully and regularly worked over the teeth, this produces the black varnish which is so much admired. Among some Malay tribes it is considered the proper thing not only to blacken the teeth, but to file them down to points like sharks' teeth.

The success which has attended the introduction from Australia of the *Vedalia cardinalis* as a remedy for the *Iceria*, or fluted orange-scale, is represented by Prof. C. V. Riley as having been phenomenal. It has fixed the attention of entomologists and of fruit-growers and farmers to the method of dealing with injurious insects by multiplying their enemies; and there is no question but that the cases in which the experiment may be more or less successfully repeated will be numerous. Fears have been expressed lest, after sweeping off the *Iceria* the *Vedalia* will perish for want of food, and the *Iceria* will increase again; but Prof. Riley thinks that this danger will work its own cure by the laws of balances. If the *Iceria* increase, the *Vedalia* will have more food, and will increase again, and so the work will go on, as according to nature.

Water extinguishes fire, not, as the common talk is, by virtue of any incompatibility between the two elements, but partly by the effect of the lowering of the temperature caused by its evaporation, and partly by acting as a mechanical extinguisher. Enveloping the parts of the body upon which it is thrown, it separates the combustible matter from the atmosphere, and cuts off the supply of oxygen—the life of the fire.

M. Berthelot has been investigating the cause of that peculiar and far from unpleasant odor which arises when vegetable soil is moistened. It proves to be produced by a camphor-like substance existing in extremely minute proportions—only a few millionths—exact analysis of which has not been practicable, on account of the small quantity obtainable. The author did not find the alcohol in the soil that M. Muntz claims to have detected there, and regards that found by M. Muntz as only an exceptional product of the spontaneous fermentation of vegetable *débris*. The new odoriferous body has a similar action with alcohol in producing iodoform.

Fromentine is the name of a new food-substance which Dr. Dujardin Beaumetz prepares by extraction from the embryos of grain seeds. On subjecting the mass obtained by collecting the embryos to a slight cooking, the proportion of albuminoid and nitrogenous substances is augmented. The water is evaporated, and the fat is separated by pressure or solution, when as much as fifty per cent of albuminoid matters and twenty-seven per cent of ternary substances are obtained. The new product contains twice as large a proportion of nitrogen as meat.

GEORGE LINCOLN GOODALE.

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THE DOCTRINE OF EVOLUTION: ITS SCOPE AND INFLUENCE.*

By JOHN FISKE.

IF you take up almost any manual or compendium of history written before the middle of the present century, you will generally find it to be a lifeless catalogue of events, and more likely than not an undiscriminating catalogue in which important and trivial events are jumbled together in utter obliviousness of any such thing as historical perspective. Of great and admirable books of history there were indeed many by illustrious writers of ancient and modern times, in which the men, the measures, and the social features of particular epochs were portrayed with life-like reality and often illustrated and criticised with a wealth of practical wisdom. But the insight into the underlying causes and the general drift of the endlessly complicated mass of human affairs was dim and uncertain, and of the essential unity of history, the solidarity in the multifarious career of mankind, there was hardly a suspicion. Three great books in narrative form, which reached out toward a presentation of the unity of history, may be cited in illustration of the difficulty under which all such attempts necessarily labored in the absence of such broad scientific conceptions as have been gained only within recent times. Bossuet's Discourse on Universal History was a work of noble design; but, being necessarily limited by the narrow theology of the time, it could only see the vast importance of the work of the Hebrew race, and, seeing no further, could not properly estimate even this; while as for any appreciation of natural causes, its perpetual appeal to the miraculous made anything of the sort quite impossible. In Voltaire's Essay on the Manners and Morals of Nations there

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is a strong foreshadowing of the unity of history, but very slight practical recognition of the differences between one stage of civilization and another, and the philosophy of the book is quite too much that of a sermon on the evils of priestcraft. In the colossal work of Gibbon there is a dramatic unity of design and a sense of historical perspective that from an artistic point of view can not be praised too highly. It is, no doubt, an immortal book, one of the classics for all ages; but as an interpretation of events it goes but little way. The period of twelve hundred years which it covers was crowded with facts of decisive import for all future time which failed to arrest the author's attention. There is no consciousness that this period, which witnessed the decline and overthrow of a certain phase of political organization, was in the main a period of lusty growth and wholesome progress rather than a period of stagnation or decline. Nor, indeed, is there any explanation of the great conspicuous fact of the decline and fall of the Roman imperial organization; we are told *what* events happened, and often *how* they happened, but we are seldom made to understand *why* they happened. The grasp upon the underlying causes is extremely feeble, as one can not but feel in a moment if, after laying down Gibbon, one picks up a volume of Mommsen, or Freeman, or Sir Henry Maine.

Most of the shortcomings of the old method of historical writing resulted from the fact that the world was looked at from a statical point of view, or as if a picture of the world were a series of detached pictures of things at rest. The human race and its terrestrial habitat were tacitly assumed to have been always very much the same as at present. One age was treated much like another, and when comparisons were made it was after a manner as different from the modern comparative method as alchemy was different from chemistry. As men's studies had not yet been turned in such a direction as to enable them to appreciate the immensity of the results that are wrought by the cumulative action of minute causes, they were disposed to attach too much importance to the catastrophic and marvelous; and the agency of powerful individuals—which upon any sound theory must be regarded as of great importance—they not only magnified unduly but rendered it unintelligible when they sought to transform human heroes into demi-gods.

It thus appears that the way in which our forefathers treated history was part and parcel of the way in which they regarded the world. Whether in history or in the physical sciences, they found themselves confronted by a seemingly chaotic mass of facts with which they could deal only in a vague and groping manner and in small detached groups. Until geology had made some headway, men had no means of knowing that the state of things upon the earth's surface was once utterly different from anything that human tradition can remember, and it was accordingly quite natural that they should suppose that things have always been about as they are. The human mind can not transcend experience. The man who has always lived in a comparatively unchanged environment will, of course, never believe in a different state of things until taught by some fresh experience. How long it was before it was brought home to men that the testimony of the unaided senses needs to be corrected by systematic observation and reasoning! From this point of view, as indeed from some others also, the revolution in astronomical theory effected by Copernicus was one of the greatest events in human history. Its philosophic consequences were profound. In teaching men the necessity of going back of superficial appearances, and subjecting their crude opinions to some kind of critical test, it was an object-lesson of unsurpassed value. Along with this abrupt shifting of man's apparent position in the universe, came the astonishing results of oceanic discovery, enlarging fourfold the dimensions of the known world and bringing the mind into contact with organic and inorganic nature in various new and unsuspected forms. Then came the Newtonian astronomy, in which a generalization from terrestrial physics was extended into the celestial spaces and quantitatively verified. There was an immense enlargement of the mental horizon, and the problems immediately connected with it were enough to occupy the attention of all the foremost mathematical minds for more than a century. It made man a denizen of the solar system as well as of his own particular planet; and in these latter days, since the law of gravitation has been extended to the sidereal heavens and spectrum analysis has begun to deal with nebulæ, there is abundant proof that properties of matter and processes with which we are familiar on this earth are to be found in some of the remotest bodies which the telescope can reach, and it is thus forcibly impressed upon us that all are parts of one stupendous whole.

This enlargement of the mental horizon, from Newton to Kirchhoff, had reference to space. A similar enlargement with reference to time was an indispensable preliminary to any correct understanding of how the world is made and what is going on in it. But, before much headway could be made in geology, it was necessary that physics and chemistry, the sciences which generalize the properties of matter, in the mass and in the molecule, should be to some extent apprehended; and it is almost startling to think how modern all this is—scarcely more than a hundred years since Priestley discovered oxygen, since it became possible to tell what goes on when you burn a log of wood on the hearth! and not so very much longer since Black discovered latent heat and gave us a clew to what happens when water freezes and melts or when it is turned into steam! It is only within fifty years that physics and chemistry have begun to assume the form of coherent bodies of scientific truth. Evidently geology could not be expected to take scientific shape until late in the eighteenth century, or to make any notable conquests before the nineteenth. But when geology did win its first great triumph, about sixty years ago, it was in some ways the most remarkable moment in the history of thought since the promulgation of the Newtonian astronomy. Newton proved that the forces which keep the planets in their orbits are not strange or supernatural forces, but just such forces as we are familiar with on this earth every moment of our lives. Geologists before Lyell had been led to the conclusion that the general aspect of the earth's surface with which we are familiar is by no means its primitive or its permanent aspect, but that there has been a succession of ages in which the relations of land and water, of mountain and plain have varied to a very considerable extent, in which soils and climates have undergone most complicated vicissitudes, and in which the earth's vegetable products and its animal populations have again and again assumed new forms while the old forms have passed away. In order to account for such wholesale changes, geologists were at first disposed to imagine violent catastrophes brought about by strange agencies—agencies which were perhaps not exactly supernatural, but in some unspecified way different from the agencies that are now at work in the visible and familiar order of Nature. But Lyell proved that the very same kind of physical processes which are now going on about us would suffice during a long period of time to produce the changes in the inorganic world which distinguish one geological period from another. Here, in Lyell's geological investigations, there was for the first time due attention paid to the immense importance of the prolonged and cumulative action of slight and unobtrusive causes. The continual dropping that wears away stones might have served as a text for the whole series of beautiful researches of which he first summed up the results in 1830. As astronomy was steadily advancing toward the proof that in the remotest abysses of space the physical forces at work are the same as terrestrial forces; so now geology, in carrying us back to enormously remote periods of time, began to teach that the forces at work have all along been the same forces that are at work now. In that early stage when the earth's crust was in process of formation, when the temperature was excessively high, there were, of course, phenomena such as can not now be witnessed here, but to find a parallel to which we must look to certain other planets—such as violent atmospheric disturbances, and such as the dissociation of chemical elements which we are accustomed to find in close combination. But since the cooling of the earth to a point at which its solid crust acquired stability, since the ancestors of the amphioxus began to swim in the seas and worms to crawl in the ground, if you could at almost any time have visited the earth, you would doubtless have found things going on at measured pace very much as at present—here and there earthquake and avalanche, fire and flood, but generally rain falling, sunshine quickening, herbage sprouting, creatures browsing, all as quiet and peaceful as a daisied field in June, without the slightest presage of the continuous series of secular changes that were gradually to transform the Carboniferous world into what was by and by to be a Jurassic world, and that again into what was after a while to be an Eocene world, and so on until the aspect of the world which we know should quietly emerge.

The influence of the new geology upon men's habits of thought and upon the drift of philosophic speculation was profound. It was proved beyond question that the world was not created in the form in which we find it to-day, but has gone through many phases of which the later are very different in aspect from the earlier; and it was shown that, at any rate so far as the inorganic world is concerned, its changes can be much more satisfactorily explained by a reference to the ceaseless, all-pervading activity of gentle, unobtrusive causes such as we know, than by an appeal to imaginary catastrophes such as we have no means of verifying. It began to appear, also, that the facts which form the subject-matter of different departments of science are not detached and independent groups of facts, but that all are intimately related one with another, and that all may be brought under contribution in illustrating the history of cosmical events. Thus, in one way and another, about the time when Mr. Darwin set out on his memorable voyage around the world, men were beginning to arrive at a vague general conception of evolution as an orderly succession of phases of nature, in which any given phase is produced from an antecedent phase through the agency of causes which are like those now in operation, and which must therefore admit of definite scientific study and explanation.

The time had at length arrived when the facts of organic life could be brought under this general conception. As long as it was supposed that each geologic period was separated from the periods immediately before and after it by Titanic convulsions which revolutionized the face of the globe, it was possible for men to acquiesce in the supposition that these convulsions wrought an abrupt and wholesale destruction of organic life, and that the lost forms were replaced by an equally abrupt and wholesale supernatural creation of new forms at the beginning of each new period. But as people ceased to believe in the convulsions, such an explanation began to seem very improbable, and it was completely discredited by the fact that many kinds of plants and animals have persisted with little or no change during several successive periods, side by side with other kinds in which there has been extensive variation and extinction. It was further observed that between the forms of successive periods in the same geographical regions there was a manifest family likeness, indicating that the later were connected with the earlier through the ordinary bonds of physical descent. A host of facts from comparative morphology and embryology went to confirm this inference; and so, when after nearly twenty years of incubation Mr. Darwin was ready to plant the seeds of his remarkable theory, he found the soil very thoroughly prepared and fertilized in which to plant them. All that men were waiting for was the discovery of a *vera causa*, All that was wanted was to be able to point to some one agency. similar to agencies now in operation and therefore intelligible, which could be proved to be capable of making specific changes in plants and animals. Mr. Darwin's solution of the problem was so beautiful, it has become so generally accepted and so deeply interfused into all the thinking of our time, it seems now so natural and so inevitable, that we may be in danger of forgetting that the problem was really one of the most complicated and abstruse that the scientific mind has ever grappled with. Starting from the known experiences of breeders of domestic animals and cultivated plants, and duly considering the remarkable and sometimes wonderful changes that are wrought by the simple process of selection, the problem before Mr. Darwin was to detect among the multifarious phenomena of organic nature any agency capable of accomplishing what man thus accomplishes by selection. In detecting the agency of *natural selection*, working perpetually through the preservation of favored individuals and races in the struggle for existence, Mr. Darwin found the *vera causa* for which men were waiting. With infinite patience and caution he applied his method of explanation to one group of organic phenomena after another, meeting in every quarter with fresh and often unexpected verification. He had the satisfaction of living to see pretty much the whole contemporary world of zoölogists, botanists, and palæontologists pursuing the lines of investigation which he had laid down and in general agreement as to the fundamental principle. There was a general acquiescence in natural selection as an agency capable of working specific changes, while further speculation and investigation in all directions were employed in ascertaining the precise character of its work and determining the limits of its efficacy. That all the phenomena of the organic world can be accounted for by natural selection, Mr. Darwin never at any time supposed; nor was he ever so silly as to suppose that all difficulties had been removed by himself or were likely to be removed within a single generation by the collective work of the whole scientific world. The present generation has witnessed a tendency toward restricting the probable limits of the efficacy of natural selection, followed by an equally marked tendency toward enlarging them—a tendency likely to be furthered by Mr. Wallace's recent book, pointing out the great extent of variation that normally goes on within the limits of one and the same species. Such minor fluctuations in scientific theory occur in all departments of inquiry, but no one doubts the essential soundness of the Darwinian theory, and as for the doctrine of special creations which it superseded, we shall probably go back to it when we go back to stone arrow-heads and the primitive Aryan ox-cart, and not before.

It has more than once been observed that, when a new discovery in science is announced to the world, people at first scout it as ridiculous or frown upon it as impious, but afterward, when it is no longer possible to gainsay it, they suddenly find that everybody knew all about it long ago. This habit is probably due to an exaggerated regard for consistency and a failure to realize that the thoughts of men are, and ought to be, widened with the progress of the suns. About the origin and history of the doctrine of evolution there is in the popular mind a great confusion of ideas; and this, as we now begin to see, is because the conception of evolution is itself something which has grown up gradually. It is an end toward which the whole momentum of scientific thought since Newton's day has been tending, yet which has been clearly and fully recognized only of late years. As regards Mr. Darwin's contribution to the general result, it admits of precise definition. The doctrine of natural selection, which Mr. Spencer afterward called "the survival of the fittest," belongs to Mr. Darwin and to Mr. Wallace as much as the differential calculus belongs to Newton and Leibnitz. The same problem was solved in the same way, first by Mr. Darwin, and then a dozen years later by Mr. Wallace in complete ignorance of what Mr. Darwin had done. "Darwinism" is the doctrine which maintains that many different forms of animal and vegetable life have a common ancestry, and which defines and describes natural selection as the chief agent in bringing about divergencies. Its distinctive feature—that which constitutes its value and its grandeur as a scientific doctrine—is the discovery and demonstration of the agency of natural selection. No one anticipated Mr. Darwin in that.

But the doctrine of natural selection is one thing, and the doctrine of evolution is quite another thing. It covers much more ground, and a good deal of it is ground with which Mr. Darwin had little or nothing to do. Vague notions of evolution were in the air long before Darwin. When Emerson speaks of the worm mounting through the various spheres of form, we are sometimes told that in this and other similar remarks he anticipated Darwin. But such language is misleading. Great writers might have gone on until the present moment expressing a conviction that higher forms of life have been evolved from lower forms, but all that would have been of small avail as scientific doctrine until somebody could show how it has been done. The belief in an evolution of higher from lower organisms was held by a few eminent men of science for a great part of the century preceding Mr. Darwin's discovery. It is a belief that could not fail to be strongly suggested to minds of a certain philosophic cast as soon as the classification of plants and animals had begun to be conducted upon scientific principles. It is not for nothing that a table of classes, orders, families, genera, and species, when graphically laid out, resembles a family tree. It was not long after Linnæus that believers in some sort of a development theory, often fantastic enough, began to appear. Palæontology gave further suggestions in the same direction. When Cuvier brought palæontology into alliance with systematic zoölogy, and effected his grand classification of animals in space and time, he prepared the way most thoroughly for a theory of evolution, though he always resisted any such inference from his work. He builded better than he knew. A general belief in development, as opposed to special creations, was held by Mr. Darwin's distinguished grandfather in England, by Lamarck and Geoffroy Saint-Hilaire in France, and by Oken and Goethe in Germany. In the present age it was maintained in print by Herbert Spencer in 1852, before Darwin had published anything on the subject.

During the early part of the present century applications of the comparative method in various directions were rapidly educating the minds of the younger generation of students into a vague perception of development as something characteristic of all sorts of phenomena. The first two great triumphs of the comparative method were achieved contemporaneously in two fields of inquiry very remote from one another: the one was the work of Cuvier just mentioned, the other was the founding of the comparative philology of the Aryan languages by Franz Bopp in 1816. The work of Bopp exerted as powerful an influence throughout all the historical fields of study as Cuvier exerted in biology. The young men whose minds were receiving their formative impulses between 1825 and 1840, under the various influences of Cuvier and Saint-Hilaire, Lyell, Goethe, Bopp, and other such great leaders, began themselves to come to the foreground as leaders of thought about 1860, on the one hand, such men as Darwin, Gray, Huxley, and Wallace; on the other hand, such as Kuhn and Schleicher, Maine, Maurer, Mommsen, Freeman, and Tylor. The point of the comparative method, in whatever field it may be applied, is that it brings before us a great number of objects so nearly alike that we are bound to assume for them an origin and general history in common, while at the same time they present such differences in detail as to suggest that some have advanced further than others in the direction in which all are traveling; some, again, have been abruptly arrested, others perhaps even turned aside from the path. In the attempt to classify such phenomena, whether in the historical or in the physical sciences, the conception of development is presented to the student with irresistible force. In the case of the Aryan languages no one would think of doubting their descent from a common original; just side by side is the parallel case of one subgroup of the Aryan languages, namely, the seven Romance languages which we know to have been developed out of the Latin since the Christian era. In these cases we can study the process of change resulting in forms that are more or less divergent from their originals. In one quarter a form is retained with little modification, in another it is completely blurred, as the Latin *metipsissimus* becomes *medesimo* in Italian, but *mismo* in Spanish, while in French there is nothing left of it but *même*. So in Sanskrit and in Lithuanian we find a most ingenious and elaborate system of conjugation and declension, which in such languages as Greek and Latin is more or less curtailed and altered, and which in English is almost completely lost. Yet in Old English there are quite enough vestiges of the system to enable us to identify it with the Lithuanian and Sanskrit.

So the student who applies the comparative method to the study of human customs and institutions is continually finding usages, beliefs, or laws existing in one part of the world that have long since ceased to exist in another part; yet where they have ceased to exist they have often left unmistakable traces of their former existence. In Australasia we find types of savagery ignorant of the bow and arrow; in aboriginal North America, a type of barbarism familiar with the art of pottery, but ignorant of domestic animals or of the use of metals; among the earliest Romans, a higher type of barbarism, familiar with iron and cattle, but ignorant of the alphabet. Along with such gradations in material culture we find associated gradations in ideas, in social structure, and in deep-seated customs. Thus, some kind of fetichism is apt to prevail in the lower stages of barbarism, and some form of polytheism in the higher stages. The units of composition in savage and barbarous societies are always the clan, the phratry, and the tribe. In the lower stages of barbarism we see such confederacies as those of the Iroquois; in the highest stage, at the dawn of civilization, we begin to find nations imperfectly formed by conquest without incorporation, like aboriginal Peru or ancient Assyria. In the lower stages we see captives tortured to death, then at a later stage sacrificed to the tutelar deities, then later on enslaved and compelled to till the soil. Through all the earlier stages of culture, as in Australasia and aboriginal America, we find the marriage tie so loose and paternity so uncertain that kinship is reckoned only through the mother. But in the highest stage of barbarism, as among the earliest Greeks, Romans, and Jews, the more definite patriarchal family is developed and kinship begins to be reckoned through the father. It is only after that stage is reached that inheritance of property becomes fully developed, with the substitution of individual ownership for clan ownership, and so on to the development of testamentary succession, individual responsibility for delict and crime, and the substitution of contract for status. In all such instances, and countless others might be cited, we see the marks of an intelligible progression, a line of development which human ideas and institutions have followed. But in the most advanced societies we find numerous traces of such states of things as now exist only among savage or barbarous societies. Our own ancestors were once polytheists, with plenty of traces of fetichism. They were organized in clans, phratries, and tribes. There was a time when they used none but stone tools and weapons, when there was no private property in land, and no political structure higher than the tribe. Among the forefathers of the present civilized inhabitants of Europe are unmistakable traces of human sacrifices and of the reckoning of kinship through the mother only. When we have come to survey large groups of facts of this sort, the conclusion is irresistibly driven home to us that the more advanced societies have gone through various stages now represented here and there by less advanced societies; that there is a general path of social development, along which, owing to special circumstances, some peoples have advanced a great way, some a less way, some but a very little way; and that, by studying existing savages and barbarians, we get a valuable clew to the interpretation of prehistoric times. All these things are to-day commonplaces among students of history and archæology: sixty years ago they would have been scouted as unintelligible and idle vagaries. Yet to this change is entirely due the superior power of modern historical methods. Formerly the historian told anecdotes or discussed particular lines of policy; now he can do that as much as ever, but he can also study nation-building and discern some features of the general drift of events from the earliest to the most recent times.

If we leave the earth and its inhabitants and turn our attention to the starry heavens, we find plenty of subjects for comparison indicating that there is a general process going on, and that this process has advanced much further in some places than in others. The general process may be roughly described as concentration of cosmical matter, with dissipation of heat. Along with this go sundry attendant or derivative chemical changes. We find gaseous nebulæ; stars ranked in different classes by their colors, perhaps indicating different stages of progress toward consolidation; then planets, first huge ones, like Saturn and Jupiter, with small density, tremendous atmospherical disturbances, and probably some remains of self-luminosity; then such as Mars, Earth, and Venus, with cool, vapor-laden atmospheres and conditions favorable to organic life; then smaller, quickly cooled and solidified globes like our barren moon; then cosmic rubbish like the asteroids and cosmic dust like the meteors. All, of course, are losing heat. Some have cooled too quickly to allow the development of life upon their surfaces; others are still too hot, but while in this stage can perhaps supply radiant heat and actinism for the support of life upon their neighbors. Obviously the gaseous nebula, being a body in an earlier stage of consolidation and containing a maximum of internal motion, is to be regarded as something like what suns and their planets were in a former stage of development.

Long before all these fruits of modern astronomical observation had been gathered, the contemplation of our sun as a consolidating and radiating body had suggested to one of the most profound thinkers that ever lived the famous nebular hypothesis as an account of the mode of development of our planetary system. The nebular hypothesis, set forth by Immanuel Kant in 1755, was the first constructive work toward a definite doctrine of evolution. The theory was restated in 1796 by Laplace, whose line of argument was very similar to Kant's. Within recent years it has received emendations and qualifications, but the fundamental conception of the nebulous mass acquiring spheroidal shape through rotation, and increasing in oblateness until at some stage in its shrinkage a portion of the equatorial surface is detached as a ring of fragments which ultimately coalesce into a satellite globe —this fundamental conception still remains as a good working hypothesis.

As we now look back over the illustrations here cited—and they are, of course, scanty enough in comparison with what might be adduced—it appears that about half a century ago the foremost minds of the world, with whatever group of phenomena they were occupied, had fallen and were more and more falling into a habit of regarding things not as having originated in the shape in which we now find them, but as having been slowly metamorphosed from some other shape through the agency of forces similar in nature to forces now at work. Whether planets, or mountains, or mollusks, or subjunctive moods, or tribal confederacies were the things studied, the scholars who studied them most deeply and most fruitfully were those who studied them as phases in a process of development. The work of such scholars has formed the strong current of thought in our time, while the work of those who did not catch these new methods has been dropped by the way and forgotten. And as we look back to Newton's time we can see that ever since then the drift of scientific thought has been setting in this direction, and with increasing steadiness and force.

Now, what does all this drift of scientific opinion during more than two centuries mean? It can, of course, have but one meaning. It means that the world *is* in a process of development, and that gradually, as advancing knowledge has enabled us to take a sufficiently wide view of the world, we have come to see that it is so. The old statical conception of a world created all at once in its present shape was the result of very narrow experience; it was entertained when we knew only an extremely small segment of the world. Now that our experience has widened, it is outgrown and set aside forever; it is replaced by the dynamical conception of a world in a perpetual process of evolution from one state into another state. This dynamical conception has come to stay with us. Our theories as to what the process of evolution is may be more or less wrong and are confessedly tentative, as scientific theories should be. But the dynamical conception, which is not the work of any one man, be he Darwin or Spencer or any one else, but the result of the cumulative experience of the last two centuries, this is a permanent acquisition. We can no more revert to the statical conception than we can turn back the sun in his course. Whatever else the philosophy of future generations may be, it must be a philosophy of evolution.

It was not strange that among the younger men whose opinions were molded between 1830 and 1840 there should have been one of organizing genius, with a mind inexhaustibly fertile in suggestions, who should undertake to elaborate a general doctrine of evolution, to embrace in one grand coherent system of generalizations all the minor generalizations which workers in different departments of science were establishing. It is this prodigious work of construction that we owe to Herbert Spencer. He is the originator and author of what we know to-day as the doctrine of evolution, the doctrine which undertakes to formulate and put into scientific shape the conception of evolution toward which scientific investigation had so long been tending. In the mind of the general public there seems to be dire confusion with regard to Mr. Spencer and his relations to evolution and to Darwinism. Sometimes, I believe, he is even supposed to be chiefly a follower and expounder of Mr. Darwin! No doubt this is because so many people mix up Darwinism with the doctrine of evolution, and have but the vaguest and haziest notions as to what it is all about. As I explained above, Mr. Darwin's great work was the discovery of natural selection and the demonstration of its agency in effecting specific changes in plants and animals; and in that work he was completely original. But plants and animals are only a part of the universe, though an important part, and with regard to universal evolution or any universal formula for evolution Darwinism had nothing to say. Such problems were beyond its scope.

The discovery of a universal formula for evolution, and the application of this formula to many diverse groups of phenomena, have been the great work of Mr. Spencer, and in this he has had no predecessor. His wealth of originality is immense, and it is unquestionable. But as the most original thinker must take his start from the general stock of ideas accumulated at his epoch, and more often than not begins by following a clew given him by somebody else, so it was with Mr. Spencer when about forty years ago he was working out his doctrine of evolution. The clew was not given him by Mr. Darwin. Darwinism was not yet born. Mr. Spencer's theory was worked out in all its parts, and most parts of it had been expounded in various published volumes and essays before the publication of The Origin of Species.

The clew which Mr. Spencer followed was given him by the great German embryologist Von Baer, and an adumbration of it may perhaps be traced back through Kaspar Friedrich Wolf to Linnæus. Hints of it may be found, too, in Goethe and in Schelling. The advance from simplicity to complexity in the development of an egg is too obvious to be overlooked by any one, and was remarked upon, I believe, by Harvey; but the analysis of what that advance consists in was a wonderfully suggestive piece of work. Von Baer's great book was published in 1829, just at the time when so many stimulating ideas were being enunciated, and its significant title was *Entwickelungsgeschichte*, or History of Evolution. It was well known that, so far as the senses can tell us, one ovum is indistinguishable from another, whether it be that of a man, a fish, or a parrot. The ovum is a structureless bit of organic matter, and in acquiring structure along with its growth in volume and mass, it proceeds through a series of differentiations, and the result is a change from homogeneity to heterogeneity. Such was Von Baer's conclusion, to which scanty justice is done by such a brief statement. As all know, his work marked an epoch in the study of embryology, for to observe and mark the successive differentiations in the embryos of a thousand animals were to write a thousand life-histories upon correct principles.

Here it was that Mr. Spencer started. As a young man he was chiefly interested in the study of political government and in history so far as it helps the study of politics. A philosophical student of such subjects must naturally seek for a theory of evolution. If I may cite my own experience, it was largely the absorbing and overmastering passion for the study of history that first led me to study evolution in order to obtain a correct method. When one has frequent occasion to refer to the political and social *progress* of the human race, one likes to know what one is talking about. Mr. Spencer needed a theory of progress. He could see that the civilized part of mankind has undergone some change from a bestial, unsocial, perpetually fighting stage of savagery into a partially peaceful and comparatively humane and social stage, and that we may reasonably hope that the change in this direction will go on. He could see, too, that along with this change there has been a building up of tribes into nations, a division of labor, a differentiation of governmental functions, a series of changes in the relations of the individual to the community. To see so much as this is to whet one's craving for enlarged resources wherewith to study human progress. Mr. Spencer had a wide general acquaintance with botany, zoölogy, and allied studies. The question naturally occurred to him, Where do we find the process of development most completely exemplified from beginning to end, so that we can follow and exhaustively describe its consecutive phases? Obviously in the development of the ovum. There and only there do we get the whole process under our eyes from the first segmentation of the yolk to the death of the matured individual. In other groups of phenomena we can only see a small part of what is going on; they are too vast for us, as in astronomy, or too complicated, as in sociology. Elsewhere our evidences of development are more or less piecemeal and scattered, but in embryology we do get, at any rate, a connected story.

So Mr. Spencer took up Von Baer's problem and carried the solution of it much further than the great German naturalist. He showed that in the development of the ovum the change from homogeneity to heterogeneity is accompanied by a change from indefiniteness to definiteness; there are segregations of similarly differentiated units resulting in the formation of definite organs. He further showed that there is a parallel and equally important change from incoherence to coherence; along with the division of labor among the units there is an organization of labor; at first among the homogeneous units there is no subordination—to subtract one would not alter the general aspect; but at last among the heterogeneous organs there is such subordination and interdependence that to subtract any one is liable to undo the whole process and destroy the organism. In other words, integration is as much a feature of development as differentiation; the change is not simply from a structureless whole into parts, but it is from a structureless whole into an organized whole with a consensus of different functions—and that is what we call an organism. So where Von Baer said that the evolution of the chick is a change from homogeneity to heterogeneity through successive differentiations, Mr. Spencer said that the evolution of the chick is a continuous change from indefinite incoherent homogeneity to definite coherent heterogeneity through successive differentiations and integrations.

But Mr. Spencer had now done something more than describe exhaustively the evolution of an individual organism. He had got a standard of high and low degrees of organization; and the next thing in order was to apply this standard to the whole hierarchy of animals and plants according to their classified relationships and their succession in geological time. This was done with most brilliant success. From the earliest records in the rocks the general advance in types of organization has been an advance in definiteness, coherence, and heterogeneity. The method of evolution in the life-history of the animal and vegetal kingdoms has been like the method of evolution in the life-history of the individual.

To go into the inorganic world with such a formula might seem rash. But as the growth of organization is essentially a particular kind of redistribution of matter and motion, and as redistribution of matter and motion is going on universally in the inorganic world, it is interesting to inquire whether in such simple approaches toward organization as we find there is any approach toward the characteristics of organic evolution as above described. It was easy for Mr. Spencer to show that the change from a nebula into a planetary system conforms to the definition of evolution in a way that is most striking and suggestive. But in studying the inorganic world Mr. Spencer was led to modify his formula in a way that vastly increased its scope. He came to see that the primary feature of evolution is an integration of matter and concomitant dissipation of motion. According to circumstances this process may or not be attended with extensive internal rearrangements and development of organization. The continuous internal rearrangement implied in the development of organization is possible only where there is a medium degree of mobility among the particles, a plasticity such as is secured only by those peculiar chemical combinations which make up what we call organic matter. In the inorganic world, where there is an approach to organization there is an adumbration of the law as realized in the organic world. But in the former what strikes us most is the concentration of the mass with the retention of but little internal mobility; in the latter what strikes us most is the wonderful complication of the transformations wrought by the immense amount of internal mobility retained. These transformations are to us the mark, the distinguishing feature of life.

Having thus got the nature of the differences between the organic and inorganic worlds into a series of suggestive formulas, the next thing to be done was to inquire into the applicability of the law of evolution to the higher manifestations of vital activity—in other words, to psychical and social life. Here it was easy to point out analogies between the development of society and the development of an organism. Between a savage state of society and a civilized state it is easy to see the contrasts in complexity of life, in division of labor, in interdependence and coherence of operations and of interests. The difference resembles that between a vertebrate animal and a worm.

Snch analogies are instructive, because at the bottom of the phenomena there is a certain amount of real identity. But Mr. Spencer did not stop with analogies; he pursued his problem into much deeper regions. There is one manifest distinction between a society and an organism. In the organism the conscious life, the psychical life, is not in the parts but in the whole; but in a society there is no such thing as corporate consciousness: the psychical life is all in the individual men and women. The highest development of this psychical life is the end for which the world exists. The object of social life is the highest spiritual welfare of the individual members of society. The individual human soul thus comes to be as much the center of the Spencerian world as it was the center of the world of mediæval theology; and the history of the evolution of conscious intelligence becomes a theme of surpassing interest.

This is the part of his subject which Mr. Spencer has handled in the most masterly manner. Nothing in the literature of psychology is more remarkable than the long-sustained analysis in which he starts with complicated acts of quantitative reasoning and resolves them into their elementary processes, and then goes on to simpler acts of judgment and perception, and then down to sensation, and so on, resolving and resolving, until he gets down to the simple homogeneous psychical shocks or pulses in the manifold compounding and recompounding of which all mental action consists. Then, starting from that conception of life as the continuous adjustment of inner relations within the organism to outer relations in the environment—a conception of which he made such brilliant use in his Principles of Biology—he shows how the psychical life gradually becomes specialized in certain classes of adjustments or correspondences, and how the development of psychical life consists in a progressive differentiation and integration of such correspondences. Intellectual life is shown to have arisen by slow gradations, and the special interpretations of reflex action, instinct, memory, reason, emotion, and will are such as to make the Principles of Psychology indubitably the most suggestive book upon mental phenomena that was ever written.

Toward the end of the first edition of The Origin of Species, published in 1859, Mr. Darwin looked forward to a distant future when the conception of gradual development might be applied to the phenomena of intelligence. But the first edition of the Principles of Psychology, in which this was so successfully done, had already been published four years before—in 1855—so that Mr. Darwin in later editions was obliged to modify his statement and confess that, instead of looking so far forward, he had better have looked about him. I remember hearing Mr. Darwin laugh merrily over this at his own expense.

This extension of the doctrine of evolution to psychical phenomena was what made it a universal doctrine, an account of the way in which the world, as we know it, has come to be. There is no subject great or small that has not come to be affected by the doctrine, and, whether men realize it or not, there is no nook or corner in speculative science where they can get away from the sweep of Mr. Spencer's thought.

This extension of the doctrine to psychical phenomena is by many people misunderstood. The Principles of Psychology is a marvel of straightforward and lucid statement; but, from its immense reach and from the abstruseness of the subject, it is not easy reading. It requires a sustained attention such as few people can command except on subjects with which they are already familiar. Hence few people read it in comparison with the number who have somehow got it into their heads that Mr. Spencer tries to explain mind as evolved out of matter, and is therefore a materialist. How many worthy critics have been heard to object to the doctrine of evolution that you can not deduce mind from the primeval nebula unless the germs of mind were present already! But that is just what Mr. Spencer says himself. I have heard him say it more than once, and his books contain many passages of equivalent import.* He never misses an opportunity for attacking the doctrine that mind can be explained as evolved from matter. But, in spite of this, a great many people suppose that the gradual evolution of mind *must* mean its evolution out of matter, and are deaf to arguments of which they do not perceive the bearing. Hence Mr. Spencer is so commonly accredited with the doctrine which he so earnestly repudiates.

But there is another reason why people are apt to suppose

* See, for example, Principles of Psychology, vol. ii, pp. 145–162.

the doctrine of evolution to be materialistic in its implications. There are able writers who have done good service in illustrating portions of the general doctrine, and are at the same time avowed materialists. One may be a materialist, whatever his scientific theory of things; and to such a person the materialism naturally seems to be a logical consequence from the scientific theory. We have received this evening a communication from Prof. Ernst Haeckel, of Jena, in which he lays down five theses regarding the doctrine of evolution:

1. "The general doctrine appears to be already unassailably founded.

2. "Thereby every supernatural creation is completely excluded.

3. "Transformism and the theory of descent are inseparable constituent parts of the doctrine of evolution.

4. "The necessary consequence of this last conclusion is the descent of man from a series of vertebrates."

So far, very good; we are within the limits of scientific competence, where Prof. Haeckel is strong. But now, in his fifth thesis, he enters the region of metaphysics—the transcendental region, which science has no competent methods of exploring—and commits himself to a dogmatic assertion:

5. "The belief in an 'immortal soul' and in 'a personal God' are therewith" (i. e., with the four preceding statements) "completely ununitable (*völlig unvereinbar*)."

Now, if Prof. Haeckel had contented himself with asserting that these two beliefs are not susceptible of scientific demonstration; if he had simply said that they are beliefs concerning which a scientific man, in his scientific capacity, ought to refrain from making assertions because Science knows nothing whatever about the subject—he would have occupied an impregnable position. His fifth thesis would have been as indisputable as his first four. But Prof. Haeckel does not stop here. He declares virtually that, if an evolutionist is found entertaining the beliefs in a personal God and an immortal soul, nevertheless these beliefs are not philosophically reconcilable with his scientific theory of things, but are mere remnants of an old-fashioned superstition from which he has not succeeded in freeing himself.

Here one must pause to inquire what Prof. Haeckel means by "a personal God." If he refers to the Latin conception of a God remote from the world of phenomena and manifested only through occasional interference—the conception that has until lately prevailed in the Western world since the time of St. Augustine—then we may agree with him; the practical effect of the doctrine of evolution is to abolish such a conception. But with regard to the Greek conception entertained by St. Athanasius; the conception of God as immanent in the world of phenomena and manifested in every throb of its mighty rhythmical life; the deity that Richard Hooker, prince of English churchmen, had in mind when he wrote of Natural Law that "her seat is the bosom of God and her voice the harmony of the world"—with regard to this conception the practical effect of the doctrine of evolution is not to abolish but to strengthen and confirm it. For, into whatever province of Nature we carry our researches, the more deeply we penetrate into its laws and methods of action, the more clearly do we see that all provinces of Nature are parts of an organic whole animated by a single principle of life that is infinite and eternal. I have no doubt Prof. Haeckel would not only admit this, but would scout any other view as inconsistent with the monism which he professes. But he would say that this infinite and eternal principle of life is not psychical, and therefore can not be called in any sense "a personal God." In an ultimate analysis, I suspect, Prof. Haeckel's ubiquitous monistic principle would turn out to be neither more nor less than Dr. Büchner's mechanical force (*Kraft*). On the other hand, I have sought to show—in my little book The Idea of God—that the Infinite and Eternal Power that animates the universe must be psychical in its nature, that any attempt to reduce it to mechanical force must end in absurdity, and that the only kind of monism which will stand the test of an ultimate analysis is monotheism. While in the chapter on Anthropomorphic Theism, in my Cosmic Philosophy, I have taken great pains to point out the difficulties in which (as finite thinkers) we are involved when we try to conceive the Infinite and Eternal Power as psychical in His nature, I have, in the chapter on Matter and Spirit, in that same book, taken equal pains to show that we are logically compelled thus to conceive Him.

One's attitude toward such problems is likely to be determined by one's fundamental conception of psychical life. To a materialist the ultimate power is mechanical force, and psychical life is nothing but the temporary and local result of fleeting collocations of material elements in the shape of nervous systems. Into the endless circuit of transformations of molecular motion, says the materialist, there enter certain phases which we call feelings and thoughts; they are part of the circuit, they arise out of motions of material molecules and disappear by being retransformed into such motions; hence, with the death of the organism in which such motions have been temporarily gathered into a kind of unity, all psychical activity and all personality are *ipso facto* abolished. Such is the materialistic doctrine, and such, I presume, is what Prof. Haeckel has in mind when he asserts that the belief in an immortal soul is incompatible with the doctrine of evolution. The theory commonly called that of the correlation of forces, and which might equally well or better be called the theory of the metamorphosis of motions, is indispensable to the doctrine of evolution. But for the theory that light, heat, electricity, and nerve-action are different modes of undulatory motion transformable one into another, and that similar modes of motion are liberated by the chemical processes going on within the animal or vegetal organism, Mr. Spencer's work could never have been done. That theory of correlation and transformation is now generally accepted, and is often appealed to by materialists. A century ago Cabanis said that the brain secretes thought as the liver secretes bile. If he were alive to-day, he would doubtless smile at this old form of expression as crude, and would adopt a more subtle phrase; he would say that "thought is transformed motion."

Against this interpretation I have maintained that the theory of correlation not only fails to support it, but actually overthrows it. The arguments may be found in the chapter on Matter and Spirit in my Cosmic Philosophy, published in 1874, and in the essay entitled A Crumb for the Modern Symposium, written in 1877 and reprinted in Darwinism and other Essays.* Their purport is, that in tracing the correlation of motions into the organism through the nervous system, and out again, we are bound to get an account of each step in terms of motion. Unless we can show that every unit of motion that disappears is transformed into an exact quantitative equivalent, our theory of correlation breaks down; but when we have shown this we shall have given a complete account of the whole affair without taking any heed whatever of thought, feeling, or consciousness. In other words, these psychical activities do not enter into the circuit, but stand outside of it, as a segment of a circle may stand outside a portion of an entire circumference with which it is concentric. Motion is never transformed into thought, but only into some other form of measurable (in fact, or, at any rate, in theory measurable) motion that takes place in nerve-threads and ganglia. *It is not the thought, but the nerve-action that accompanies the thought, that is really "transformed motion."* I say that, if we are going to verify the theory of correlation, it must be done (actually or theoretically) by measurement; quantitative equivalence must be proved at every step; and hence we must not change our unit of measurement; from first to last it must be a unit of motion: if we change it for a moment, our theory of correlation that moment collapses. I say, therefore, that the theory of correlation and equivalence of forces lends no support whatever to materialism. On the contrary, its manifest implication is that psychical life can not be a mere product of temporary collocations of matter.

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* See also Excursions of an Evolutionist, pp. 274–282.

The argument here set forth is my own. When I first used it I had never met with it anywhere in books or conversation. Whether it has since been employed by other writers I do not know, for during the past fifteen years I have read very few books on such subjects. At all events, it is an argument for which I am ready to bear the full responsibility. Some doubt has recently been expressed whether Mr. Spencer would admit the force of this argument. It has been urged by Mr. S. H. Wilder, in two able papers published in the New York Daily Tribune, June 13 and July 4, 1890, that the use of this argument marks a radical divergence on my part from Mr. Spencer's own position. It is true that in several passages of First Principles there are statements which either imply or distinctly assert that motion can be transformed into feeling and thought—e. g., "Those modes of the Unknowable which we call heat, light, chemical affinity, etc., are alike transformable into each other, and into those modes of the Unknowable which we distinguish as sensation, emotion, thought: these, in their turns, being directly or indirectly retransformable into the original shapes" (First Principles, second edition, 1867, p. 217); and again it is said "to be a necessary deduction from the law of correlation, that what exists in consciousness under the form of feeling is transformable into an equivalent of mechanical motion," etc. (First Principles, second edition, p. 558). Now, if this, as literally interpreted, be Mr. Spencer's deliberate opinion, I entirely dissent from it. To speak of quantitative equivalence between a unit of feeling and a unit of motion seems to me to be talking nonsense—to be combining terms which severally possess a meaning into a phrase which has no meaning. I am, therefore, inclined to think that the above sentences, literally interpreted, do not really convey Mr. Spencer's opinion. They appear manifestly inconsistent, moreover, with other passages in which he has taken much more pains to explain his position (e. g., Principles of Psychology, pp. 158–161, 616–627). In the sentence of p. 558 of First Principles, Mr. Spencer appears to me to mean that the nerve-action, which is the objective concomitant of what is subjectively known as feeling, is transformable into an equivalent of mechanical motion. When he wrote that sentence perhaps he had not shaped the case quite so distinctly in his own mind as he had a few years later, when he made the more elaborate statements in the Psychology. Though in these more elaborate statements he does not assert the doctrine I have here maintained, yet they seem consistent with it. When I was finishing the chapter on Matter and Spirit, in my room in London one afternoon in February, 1874, Mr. Spencer came in, and I read to him nearly the whole chapter, including my argument from correlation above mentioned. He expressed warm approval of the chapter, without making any specific qualifications. In the course of the chapter I had occasion to quote a passage from the Psychology (vol. i, p. 158; cf. Cosmic Philosophy, vol. ii, p. 444), in which Mr. Spencer twice inadvertently used the phrase "nervous shock" where he meant "psychical shock." As his object was to keep the psychical phenomena and their cerebral concomitants distinct in his argument, this colloquial use of the word "nervous" was liable to puzzle the reader, and give the querulous critic a chance to charge Mr. Spencer with the materialistic implications which it was his express purpose to avoid. Accordingly, in my quotation I changed the word "nervous" to "psychical," using brackets and explaining my reasons. On showing all this to Mr. Spencer, he desired me to add in a foot-note that he thoroughly approved the emendation.

I mention this incident because our common, every-day speech abounds in expressions that have a materialistic flavor; and sometimes in serious writing an author's sheer intentness upon his main argument may lead him to overlook some familiar form of expression which, when thrown into a precise and formal context, will strike the reader in a very different way from what the author intended. I am inclined to explain in this way the passages in First Principles which are perhaps chiefly responsible for the charge of materialism that has so often and so wrongly been brought up against the doctrine of evolution.

As regards the theological implications of the doctrine of evolution, I have never undertaken to speak for Mr. Spencer; on such transcendental subjects it is quite enough if one speaks for one's self. It is told of Diogenes that, on listening one day to a sophistical argument against the possibility of motion, he grimly got up out of his tub and walked across the street. Whether his adversaries were convinced or not, we are not told. Probably not; it is but seldom that adversaries are convinced. So, when Prof. Haeckel declares that belief in a "personal God" and an "immortal soul" are incompatible with acceptance of the doctrine of evolution, I can only say, for myself—however much or little the personal experience may be worth—I find that the beliefs in the psychical nature of God and in the immortality of the human soul seem to harmonize infinitely better with my general system of cosmic philosophy than the negation of these beliefs. If Prof. Haeckel, or any other writer, prefers a materialistic interpretation, very well. I neither quarrel with him nor seek to convert him; but I do not agree with him. I do not pretend that my opinion on these matters is susceptible of scientific demonstration. Neither is his. I say, then, that his fifth thesis has no business in a series of scientific generalizations about the doctrine of evolution.

Far beyond the limits of what scientific methods, based upon our brief terrestrial experience, can demonstrate, there lies on every side a region with regard to which Science can only suggest questions. As Goethe so profoundly says:

> "Willst du ins Unendliche streiten,
> Geh' nur im Endlichen nach allen Seiten."*

It is of surpassing interest that the particular generalization which has been extended into a universal formula of evolution should have been the generalization of the development of an ovum. In enlarging the sphere of life in such wise as to make the whole universe seem actuated by a single principle of life, we are introduced to regions of sublime speculation. The doctrine of evolution, which affects our thought about all things, brings before us with vividness the conception of an ever-present God—not an absentee God who once manufactured a cosmic machine capable of running itself except for a little jog or poke here and there in the shape of a special providence. The doctrine of evolution destroys the conception of the world as a machine. It makes God our constant refuge and support, and Nature his true revelation; and when all its religious implications shall have been set forth, it will be seen to be the most potent ally that Christianity has ever had in elevating mankind.

Mr. G. L. Gomme makes a distinction between the anthropological and the literary schools of folk-lorists. The work of the former has only just begun; the latter has been at work for a long time, although the results it has obtained do not seem to be advancing beyond the dictum that what is recorded chronologically earlier must be the parent of that which is recorded later, the second being the central point of importance, not the thing recorded. The results of the anthropological school show great and continuing advance. From analysis of folk tales it becomes clear that in the majority of stories the central part of the plot is some savage or rudely barbarous idea or custom. By analyzing custom and belief, and tracing out their geographical distribution in each country, much would be gained toward placing folk lore as one of the factors for elucidating the prehistoric life of man. As examples of such analysis, baptism beliefs, witchcraft customs, the burning of the clavie, and some sacrificial rites in Devonshire, were given in the author's paper, and the evidence was pointed out which suggests that they contain some unpublished details of the practices of the stone age. Further, Mr. Gomme urged the importance of studying folk lore by exact methods.

According to Mr. W. T. Thiselton Dyer, of Kew Gardens, Alpine plants are the reverse of hardy. He believes that they are for the most part intolerant of very low temperature, and are certainly extremely impatient of humidity during the comparatively long period when they are not in active growth. For these reasons the collections at Kew are wintered under glass. These peculiarities are accounted for by the fact that in nature, except for a short time, Alpine plants are covered with snow, which keeps them dry and protects them from a very low temperature.

* ["If thou wouldst press into the infinite, go but to all parts of the finite."]

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XIII. FROM FETICH TO HYGIENE.

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II.

WE have now seen how powerful in various nations especially obedient to theology were the forces working in opposition to the evolution of hygiene. We shall find this same opposition, less effective, it is true, but still acting with great power in countries which had become somewhat emancipated from theological control. In England, during the mediæval period, persecutions of Jews were occasionally resorted to, and here and there we hear of dealings with witches; but, as torture was rarely used in England, there were few of those torture-born confessions of persons charged with producing plague which in other countries gave rise to wide-spread cruelties. Down to the sixteenth and seventeenth centuries the filthiness in the ordinary mode of life in England was such as we can now hardly conceive: fermenting organic material was allowed to accumulate and become a part of the earthen floors of rural dwellings; and this undoubtedly developed the germs of many diseases. In his noted letter to the physician of Cardinal Wolsey, Erasmus describes the filth thus incorporated into the floors of English houses, and, what is of far more importance, he had an inkling of the true cause of the wasting diseases of the period. He says, "If I entered into a chamber which had been uninhabited for months, I was immediately seized with a fever." He ascribed the fearful plague of the sweating sickness to this cause. So, too, the noted Dr. Caius advised sanitary precautions against the plague; and in after-generations, Mead, Pringle, and others urged them; but the prevailing thought was too strong, and little was done. Even the floor of the presence-chamber of Queen Elizabeth in Greenwich Palace was "covered with hay, after the English fashion," as one of the chroniclers tells us. In the seventeenth century, aid in these great scourges was mainly sought in special church services; the foremost English churchmen during that century being greatly given to study of the early fathers of the Church, the theological theory of disease, so dear to the fathers, still held sway, and this was the case when the various visitations reached their climax in the great plague of London in 1665, which swept off more than a hundred thousand people from that city. The attempts at meeting it by sanitary measures were few and poor; the medical system of the time was still largely tinctured by superstitions resulting from mediæval modes of thought; hence that plague was generally attributed to the divine wrath caused by "the prophaning of the Sabbath." Texts from Numbers, the Psalms, Zechariah, and the Apocalypse were dwelt upon in the pulpits to show that plagues are sent by the Almighty to punish sin; and perhaps the most ghastly figure among all those fearful scenes described by De Foe is that of the naked fanatic walking up and down the streets with a pan of fiery coals upon his head, and, after the manner of Jonah at Nineveh, proclaiming woe to the city and its destruction in forty days.

That sin caused this plague is certain, but it was sanitary sin; both before and after this culmination of the disease cases of plague were constantly occurring in London throughout the seventeenth century; but about the beginning of the eighteenth century it began to disappear; the great fire had done a good work by sweeping off many causes and centers of infection, and there had come wider streets, better pavements, and improved water-supply; so that with the disappearance of the plague, other diseases, especially dysenteries, which had formerly raged in the city, became much less frequent.

But while these epidemics were thus checked in London, others developed by sanitary sin raged fearfully both there and elsewhere, and of these perhaps the most fearful was the jail-fever. The prisons of that period were vile beyond belief. Men were confined in dungeons rarely if ever disinfected after the death of previous occupants, and on corridors connecting directly with the foulest sewers; there was no proper disinfection, ventilation, or drainage; hence in most of the large prisons for criminals or debtors the jail-fever was supreme, and from these centers it frequently spread through the adjacent towns. This was especially the case during the sixteenth and seventeenth centuries. In the Black Assize at Oxford in 1577 the chief baron, the sheriff, and about three hundred men died within forty hours. Lord Bacon declared the jail-fever "the most pernicious infection next to the plague." In 1730, at the Dorsetshire Assize, the chief baron and many lawyers were killed by it. The High Sheriff of Somerset also took the disease and died. A single Scotch regiment being infected from some prisoners, lost no less than two hundred. In 1750, the disease was so virulent at Newgate, in the heart of London, that two judges, the lord mayor, sundry aldermen, and many others died of it.

It is worth noting that while efforts at sanitary dealing with this state of things were few, the theological spirit developed special forms of prayer for prisoners, and especially that a new prayer was placed in the Irish Prayer-book.

These forms of prayer seem to have been the main reliance through the first half of the eighteenth century. But about 1750 began the work of John Howard: among other evidences of saintship he visited the prisons of England, made known their condition to the world, and never rested until they were greatly improved. Then he applied the same benevolent activity to prisons in other countries, in the far East and in southern Europe, and finally laid down his life, a victim to disease contracted on one of his missions of mercy; but the hygienic reforms he began were developed more and more until this fearful blot upon modern civilization was removed.*

The same thing was seen in the Protestant colonies of America; but here, while plagues were steadily attributed to divine wrath or satanic malice, there was one case in which it was claimed that such a visitation was due to the divine mercy: the pestilence among the *Indians,* before the arrival of the Plymouth Colony, was attributed in a notable work of that period to the divine purpose of clearing New England for the heralds of the gospel; on the other hand, the plagues which destroyed the *white* population were attributed by the same authority to devils and witches. In Increase Mather's Wonders of the Invisible World, published at Boston in 1693, we have striking examples of this. The great Puritan divine tells us:

"Plagues are some of those woes, with which the Divil troubles us. It is said of the Israelites, in 1 Cor. 10. 10. *They were destroyed of the destroyer.* That is, they had the Plague among them. 'Tis the Destroyer, or the Divil, that scatters Plagues about the World: Pestilential and Contagious Diseases, 'tis the Divel, who do's oftentimes Invade us with them. 'Tis no uneasy thing, for the Divel, to impregnate the Air about us, with such Malignant Salts, as meeting with the Salt of our Microcosm, shall immediately cast us into that Fermentation and Putrefaction, which

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* For Erasmus, see the letter cited in Bascome, History of Epidemic Pestilences, London, 1851. For account of the condition of Queen Elizabeth's presence-chamber, see the same, p. 206. See also the same for attempts at sanitation by Caius, Mead, Pringle, and others. See Baas and various medical authorities. For the plague in London, see Green's History of the English People, chap. ix, sec. 2; and for a more detailed account, see Lingard, History of England, enlarged edition of 1849, vol. ix, p. 107 *et seq.* For the London plague as a punishment for Sabbath-breaking, see A divine Tragedie lately acted, A collection of sundrie memorable examples of God's judgements upon Sabbath Breakers and other like libertines, etc. By that worthy Divine, Mr. Henry Burton, 1641. The book gives fifty-six accounts of Sabbath-breakers sorely punished, generally struck dead, in England, with places, names, and dates. For a general account of the condition of London in the sixteenth and seventeenth centuries, and the diminution of the plague by the rebuilding of some parts of the city after the great fire, see Lecky, History of England in the Eighteenth Century, vol. i, pp. 592, 593. For the jail-fever, see Lecky, vol. i, pp. 500–503.

will utterly dissolve All the Vital Tyes within us; Ev'n as an Aqua Fortis, made with a conjunction of Nitre and Vitriol, Corrodes what it Siezes upon. And when the Divel has raised those Arsenical Fumes, which become Venomous Quivers full of Terrible Arrows, how easily can he shoot the deleterious Miasms into those Juices or Bowels of Mens Bodies, which will soon Enflame them with a Mortal Fire! Hence come such Plagues, as that Beesome of Destruction which within our memory swept away such a throng of people from one English City in one Visitation: and hence those Infectious Feavers, which are but so many Disguised Plagues among us, Causing Epidemical Desolations" (pp. 17 and 18).

Mather gives several instances of witches causing diseases, and speaks of "some long Bow'd down under such a Spirit of Infirmity," being "Marvelously Recovered upon the Death of the Witches," of which he gives an instance. He also gives an instance where a patient "was brought unto death's door and so remained until the witch was taken and carried away by the constable, when he began at once to recover and was soon well." *

In France we see, during generation after generation, a similar history evolved; pestilence after pestilence came, and was met by various fetiches. Noteworthy is the plague at Marseilles near the beginning of the last century. The chronicles of its sway are ghastly. They speak of great heaps of the unburied dead in the public places, "forming pestilential volcanoes"; of plague-stricken men and women in delirium wandering naked through the streets; of churches and shrines thronged with great crowds shrieking for mercy; of other crowds flinging themselves into the wildest debauchery; of robber bands plundering the dead and assassinating the dying; of three thousand neglected children collected in one hospital and then left to die; and of the death-roll numbering at last fifty thousand out of a population of less than ninety thousand.

In the midst of these fearful scenes stood a body of men and women worthy to be held in eternal honor—the physicians from Paris and Montpellier; the mayor of the city, and one or two of his associates; but, above all, the Chevalier Roze and Bishop Belzunce. The history of these men may well make us glory in human nature; but in all this noble group the figure of Belzunce

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* For the passages cited from Increase Mather, see in his book as cited, pp. 17, 18, also 134, 145. Johnson's History of New England, published in London in 1654, declares that "By this meanes Christ . . . not only made roome for His people to plant, but also tamed the hard and cruell hearts of these barbarous Indians, insomuch that halfe a handful of His people landing not long after in Plymouth Plantation, found little resistance." See the History of New England, by Edward Johnson, London, 1654. Reprinted in Massachusett's Historical Society's Collection, second series, vol. i, p. 67.

is the most striking. Nobly and firmly, when so many others even among the regular and secular ecclesiastics fled, he stood by his flock: day and night he was at work in the hospitals, cheering the living, comforting the dying, and doing what was possible for the decent disposal of the dead. In him were united the two great antagonistic currents of religion and of theology. As a theologian he organized processions and expiatory services, which, it must be confessed, rather increased the sway of the disease than diminished it; moreover, he accepted that wild dream of a hysterical nun—the worship of the material, physical sacred heart of Jesus—and was one of the first to consecrate his diocese to it; but, on the other hand, the religious spirit gave in him one of its most beautiful manifestations in that or any other century: justly have the people of Marseilles placed his statue in the midst of their city in an attitude of prayer and blessing.

In every part of Europe and America, down to a recent period, we find pestilences resulting from carelessness or superstition still called "inscrutable providences." As late as the end of the eighteenth century, when great epidemics made fearful havoc in Austria, the main means against them seem to have been the special "witch-doctors"—that is, monks who cast out devils. To seek the aid of physicians was, in the neighborhood of these monastic centers, very generally considered impious, and the enormous death-rate in such neighborhoods was only diminished in the present century when scientific hygiene began to make its way.

The old view of pestilence had also its full course in Calvinistic Scotland—the only difference being that, while in Roman Catholic countries relief was sought by fetiches, gifts, processions, exorcisms, and works of expiation, promoted by priests; in Scotland, after the Reformation, it was sought in fast-days established by Presbyterian elders. Accounts of the filthiness of Scotch cities and villages, as well as of ordinary dwellings, down to a period well within this century, seem monstrous. All that in these days is swept into the sewers, was in those allowed to remain around the houses or thrown into the streets. The old theological theory that "vain is the hand of man," checked scientific thought and paralyzed sanitary endeavor. The result was natural: between the thirteenth and seventeenth centuries thirty notable epidemics swept the country, and some of them carried off multitudes; but as a rule these never suggested sanitary improvement; they were called "visitations," attributed to divine wrath against human sin, and the work of the authorities was to announce the particular sin concerned, and to declaim against it. Amazing theories were thus propounded—theories which led to spasms of severity; and, in some of these, offenses generally punished much less severely were visited with death. Every pulpit interpreted the ways of God to man in such seasons so as rather to increase than to diminish the pestilence. The effect of thus seeking supernatural causes rather than natural may be seen in such facts as the death by plague of one fourth of the whole population of the city of Perth in a single year of the fifteenth century; other towns suffering similarly both then and afterward.

Here and there, physicians more wisely inspired endeavored to push sanitary measures, and in 1585 attempts were made to clean the streets of Edinburgh, but the chroniclers tell us that "the magistrates and ministers gave no heed." One sort of calamity, indeed, came in as a mercy—the great fires which swept through the cities, clearing and cleaning them. Though the town council of Edinburgh declared the noted fire of 1700 "a fearful rebuke of God," it was observed that, after it had done its work, disease and death were greatly diminished.*

But by those standing in the higher places of thought some glimpses of scientific truth had already been obtained, and attempts at compromise between theology and science in this field began to be made, not only by ecclesiastics, but first of all, as far back as the seventeenth century, by a man of science, eminent both for attainments and character—Robert Boyle. Inspired by the discoveries in other fields, which had swept away so much of theological thought, he could no longer resist the conviction that some epidemics are due, in his own words, "to a tragical concourse of natural causes"; but he argued that some of these may be the result of divine interpositions provoked by human sins. As time went on, great difficulties showed themselves in the way of this compromise—difficulties theological not less than difficulties scientific. To a Catholic it was more and more hard to explain the theological grounds why so many orthodox cities, firm in the faith, were punished, and so many heretical cities spared, and why, in regions devoted to the Church, the poorer people, whose faith in theological fetiches was unquestioning, died in times of pestilence like flies, while skeptics so frequently escaped. Difficulties of the same sort beset devoted Protestants; they, too, might well ask why it was that the devout peasantry in their humble cottages perished, while so much larger a proportion of the more skeptical upper classes were untouched.

* For the plague at Marseilles and its depopulation, see Henri Martin, Histoire de France, vol. xv, especially document cited in appendix; also Gibbon, Decline and Fall, chap. xliii; also Rambaud. For the resort to witch-doctors in Austria against pestilence, down to the end of the eighteenth century, see Biedermann, Deutschland im Achtzehnten Jahrhundert. For the reign of filth and pestilence in Scotland, see Charles Rogers, D. D., Social Life in Scotland, Edinburgh, 1884, vol. i, pp. 305–316; see also Buckle's second volume.

Gradually it dawned both upon Catholic and Protestant countries that, if any sin be punished by pestilence, it is the sin of filthiness; more and more it began to be seen by thinking men of both religions that Wesley's great dictum stated even less than the truth; that not only was "cleanliness akin to godliness," but that, as a means of keeping off pestilence, it was far superior to godliness as godliness was then generally understood.*

The recent history of sanitation in all civilized countries shows triumphs which may well fill us with wonder, did there not rise within us a far greater wonder that they were so long delayed. Amazing is it to see how near the world has come again and again to discovering the key to the cause and cure of pestilence. It is now a matter of the simplest elementary knowledge that some of the worst epidemics are conveyed in water. But this fact seems to have been discovered many times in human history. In the Peloponnesian war the Greeks asserted that their enemies had poisoned their cisterns; in the middle ages the people generally declared that the Jews had poisoned their wells; and as late as the cholera of 1832 the Parisian mob charged the water-carriers who distributed water for drinking purposes from the Seine, polluted as it was by sewage, with poisoning the water, and in some cases murdered them for it; so far did this feeling go, that locked covers were sometimes placed upon the water-buckets. Had not such men as Roger Bacon and his long line of successors been thwarted by theological authority—had not such men as Thomas Aquinas, Vincent de Beauvais, and Albert the Great been drawn or driven from the paths of science into the dark, tortuous paths of theology, leading nowhither, the world to-day, at the end of the nineteenth century, would have arrived at the solution of great problems and the enjoyment of great results which will only be reached at the end of the twentieth century, and even in generations more remote. Diseases like pulmonary consumption, scarlet fever, diphtheria, pneumonia, and *la grippe*, which now carry off so many most precious lives, would have long since ceased to scourge the world.

Still, there is one great cause for joy: the law governing the relation of theology to disease is now well before the world, and it is seen in the striking fact that just in proportion as the world progressed from the sway of Hippocrates to that of the ages of faith, so it progressed in the frequency and severity of great pestilences; and, on the other hand, just in proportion as the world has receded from that period when theology was all-pervading and all-controlling, plague after plague has disappeared, and

* For Boyle's attempt at compromise, see Discourse on the Air, in his works, vol. iv, pp. 288, 289, cited by Buckle, vol. i, pp. 128, 129, note.

those remaining have become less and less frequent and virulent.*

The recent history of hygiene in all countries shows a long series of victories, and these may well be studied in Great Britain and the United States. In the former, though there had been many warnings from eminent physicians, and, above all, in the seventeenth and eighteenth centuries, from men like Caius, Mead, and Pringle, the result was far short of what might have been gained; and it was only in the year 1838 that a systematic sanitary effort was begun in England by the public authorities. The state of things at that time, though by comparison with the middle ages happy, was, by comparison with what has since been gained, fearful; the death-rate among all classes was high, but among the poor it was ghastly. Out of seventy-seven thousand paupers in London during the years 1837 and 1838, fourteen thousand were suffering from fever, and of these nearly six thousand from typhus. In many other parts of the British Islands the sanitary condition was no better. A noble body of men grappled with the problem, and in a few years one of these rose above his fellows—the late Edwin Chadwick. The opposition to his work was bitter, and, though many churchmen aided him, the support given by theologians and ecclesiastics as a whole was very far short of what it should have been. Too many of them were occupied in that most costly of all processes, "the saving of souls" by the inculcation of dogma. Yet some of the higher ecclesiastics and many of the lesser clergy did much, sometimes risking their lives, and one of them, Sidney Godolphin Osborne, deserves lasting memory for his struggle to make known the sanitary wants of the peasantry.

Chadwick began to be widely known in 1848 as a member of the Board of Health, and was driven out for a time for overzeal; but from one point or another, during forty years, he fought the opposition, developed the new work, and one of the best exhibits of its results is shown in his address before the Sanitary Conference at Brighton in 1888. From this and other perfectly trustworthy sources some idea may be gained of the triumph of the scientific over the theological method of dealing with disease, whether epidemic or sporadic.

In the latter half of the seventeenth century the mortality of London is estimated to have been not less than eighty per thousand; about the middle of this century it stood at twenty-four in a thousand; in 1889 it stood at less than eighteen in a thousand; and in many parts the most recent statistics show that it has been

* For the charge of poisoning water and producing pestilence among the Greeks, see Grote's History of Greece, vi, 213. For a similar charge against the Jews in the middle ages, see various histories already cited; and for the great popular prejudice against water-carriers at Paris in recent times, see the larger recent French histories.

brought down to fourteen or fifteen in a thousand. A quarter of a century ago the death-rate from disease in the Royal Guards at London was twenty per thousand; in 1888 it had been reduced to six in a thousand. In the army generally it had been seventeen in a thousand, but it has been reduced until it now stands at eight. In the old Indian army it had been sixty-nine in a thousand; but of late it has been brought down, first to twenty, and finally to fourteen. Mr. Chadwick in his speech proved that much more might be done, for he called attention to the German army, where the death-rate from disease has been reduced to between five and six in a thousand. Between 1871 and 1880 the death-rate in England among men fell more than four in a thousand, and among women more than six in a thousand. In the decade between 1851 and 1860 there died of zymotic diseases over four thousand persons in every million throughout England; these numbers have declined until in 1888 there died less than two thousand in every million. As to the scourge which, next to plagues like the black death, was formerly the most dreaded—small-pox—there died of it in London during the year 1890 just one person. Drainage in Bristol reduced the death-rate by consumption from 4·4 to 2·3; at Cardiff, from 3·47 to 2·31; and in all England and Wales from 2·68 in 1851 to 1·55 in 1888.

What can be accomplished by better sanitation is also seen to-day by a comparison between the death-rate among the children outside and inside the charity schools. The death-rate among those outside in 1881 was twelve in a thousand; while inside, where the children were under sanitary regulations, maintained by competent authorities, it has been brought down, first to eight, then to four, and finally to less than three in a thousand.

In view of statistics like these, it becomes clear that Edwin Chadwick and his compeers among the sanitary authorities have in half a century done far more to reduce the rate of disease and death than has been done in fifteen hundred years by all the fetiches which theological reasoning could devise or ecclesiastical power enforce.

Not less striking has been the history of hygiene in France; thanks to the decline of theological control over the universities, to the abolition of monasteries, and to such labors in hygienic research and improvement as those of a succession of men like Tardieu, Levy, and Bouchardat, a wondrous change has been wrought in public health. Statistics carefully kept show that the mean length of human life has been remarkably increased. In the eighteenth century it was but twenty-three years; from 1825 to 1830 it was thirty-two years and eight months; and since 1864, thirty-seven years and six months. The question may come up here whether this progress has been purchased at any real sacrifice of religion in its highest sense. One piece of recent history enables us to answer this question. The Second Empire in France had its head in Napoleon III, a noted Voltairean. At the climax of his power he determined to erect an Academy of Music, which should be the noblest building of its kind in the world. It was projected on a scale never before known, at least in modern times, and carried on for years, millions being lavished upon it. But at the same time the emperor determined to rebuild the Hôtel-Dieu, the great Paris hospital; this, too, was projected on a greater scale than anything of the kind ever before known, and also required millions. In the erection of these two buildings the emperor's determination was distinctly made known, that with the highest provision for intellectual enjoyment there should be a similar provision, and moving on parallel lines with it, for the relief of human suffering. This plan was carried out to the letter; the Palace of the Opera and the Hôtel-Dieu went on with equal steps, and the former was not allowed to be finished before the latter. Among all the "most Christian kings" of the house of Bourbon who had preceded him for five hundred years, history shows no such obedience to the religious and moral sense of the nation. Catharine de' Medici and her sons, plunging the nation into the great wars of religion, never showed any such feeling; Louis XIV, revoking the edict of Nantes for the glory of God, and bringing the nation to sorrow for hundreds of years, never dreamed of making the construction of his palaces and public buildings wait upon the demands of charity; Louis XV, so subservient to the Church in all things, never betrayed the slightest consciousness that while making enormous expenditures to gratify his own and the national vanity, he ought to carry on works, *pari passu*, for charity. Nor did the French nation, at those periods when it was most largely under the control of theological considerations, seem to have any inkling of the idea that nation or monarch should make provision for relief from human suffering, to justify provision for the sumptuous enjoyment of art: it was reserved for the second half of the nineteenth century to develop this feeling so strongly, though quietly, that Napoleon III, notoriously an unbeliever in all orthodoxy, was obliged to recognize it and to set this great example.

Nor has the recent history of the United States been less fruitful in lessons. Yellow fever, which formerly swept not only Southern cities but even New York and Philadelphia, has now been almost entirely warded off. Such epidemics as that in Memphis a few years since, and the immunity of the city from such visitations since its sanitary condition was changed by Mr. Waring, are a most striking object-lesson to the whole country. Cholera, which again and again swept the country, has ceased to be feared by the public at large. Typhus fever, once so deadly, is now rarely heard of. Curious is it to find that some of the diseases which in the olden time swept off myriads on myriads in every country, now cause fewer deaths than some diseases thought of little account, and for the cure of which, therefore, people rely to their cost on quackery instead of medical science.

This development of sanitary science and hygiene in the United States has been coincident with a marked change in the attitude of the American pulpit as regards the theory of disease. In this country, as in others, down to a period within living memory, deaths due to want of sanitary precautions were constantly dwelt upon in funeral sermons as "results of national sin," or as "inscrutable Providences." That view has mainly passed away among the clergy of the more enlightened parts of the country, and we now find them, as a rule, active in spreading useful ideas as to the prevention of disease; the religious press has been especially faithful in this respect, carrying to every household more just ideas of sanitary precautions and hygienic living.

In summing up the whole subject, we see in this field another of those great triumphs of scientific modes of thought which are gradually doing so much to evolve in the world a religion which shall be more and more worthy of the goodness of God and of the destiny of man.*

Mr. Grum Grzimailo has brought four specimens of the wild horse (*Equus Prejevalsky*) home to St. Petersburg from central Asia. He has found that a part of the oasis of Turfan is below the level of the sea, and believes that it represents the bottom of a former lake of considerable extent.

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* On the improvement in sanitation in London and elsewhere in the north of Europe, see the editorial and Report of the Conference on Sanitation at Brighton, given in the London Times of August 27, 1888. For the best authorities on the general subject in England, see Sir John Simon on English Sanitary Institutions, 1890; also his published Health Reports for 1887, cited in the Edinburgh Review for January, 1891. See also Parkes's Hygiene, *passim*. For the great increase of the mean length of life in France under better hygienic conditions, see Rambaud, La Civilisation contemporaine en France, p. 682. For the approach to depopulation at Memphis, under the cesspool system in 1878, see Parkes, Hygiene, American appendix, p. 397. For the facts brought out in the investigation of the departments of the city of New York, by the Committee of the State Senate, see New York Senate documents for 1865. For decrease of death-rate in New York city under the new Board of Health, beginning in 1866, and especially among children, see Buck, Hygiene and Popular Health, New York, 1879, vol. ii, p. 575; and for wise remarks on religious duties during pestilence, see ibid., vol. ii, p. 579. For a contrast between the old and new ideas regarding pestilences, see Charles Kingsley in Fraser's Magazine, lviii, 134; also the sermon of Dr. Burns in 1875 at the Cathedral of Glasgow, before the Social Science Congress. For a particularly bright and valuable statement of the triumphs of modern sanitation, see Mrs. Plunkett's article in The Popular Science Monthly for June, 1891

GLASS-MAKING.

V.—GLASS IN SCIENCE.

By C. HANFORD HENDERSON,

PROFESSOR OF PHYSICS AND CHEMISTRY IN THE PHILADELPHIA MANUAL TRAINING SCHOOL.

WHEN we compare the modern man, the product of many centuries of more or less continuous culture, with the men of ancient Rome, and still more with the men of ancient Greece, the impression unwillingly forces itself upon us that man has somewhat deteriorated since the days of Carthage and Thermopylæ. The reflection is a discouraging one. But observe how unavoidable it is. The modern man can not run so far or so fast, can not see so well, hear so acutely, or speak so loud. All his direct physical powers have suffered diminution. If the comparison be extended to the intellectual world, it is clearly manifest that the loss of power in one direction has not been compensated by the gain in another. One need have no great turn for Hellenism to perceive that the average American, despite his boasting, appears but a struggling child beside the heroes of either the Olympian games or the Athenian groves.

The effect of such a comparison as this is to make one question the truth of human evolution, and to ask himself in all seriousness whether the history of the race is not one of retrogression rather than of advance. But there is another way of looking at the matter, and there are other factors which must needs be taken into consideration.

The suggestion, I believe, is due to Mr. Spencer that, in attempting to measure man's physical power, the summary should not be limited to his direct faculties, but should justly include the acquisitions gained through the exercise of his intelligence. Thus, while it is perfectly true that modern legs are not so sturdy as Grecian legs, it must not be forgotten that by means of steamer and railway the modern man can girdle the earth in a couple of months, and can travel almost unlimited distances at the rate of fifty miles an hour. At the present moment popular lecturers are demonstrating that there is no reason why he should not go two and a half miles a minute. Since this facility of movement is the product of his own increasing development, we must admit that a longer view establishes an increased power of locomotion in the history of the race, and that even here evolution has been constant. The modern vision is faulty and astigmatic. We are veritable bats compared to the men of antiquity, or even to the modern American Indian. But here, again, the brain has more than compensated the defects of the eye. By means of the microscope we see a world completely hidden from the more powerful eyesight of antiquity. By means of the telescope we study a multitude of distant worlds about which the Indian can not even speculate.

Stentor lived on the banks of the Bosporus, not in a busy American seaport. The modern Stentor, with less perfect throat and lung and ear, speaks through telegraph and telephone across oceans and continents; and, in the phonograph, talks without regard to time or place.

One's first impression, then, of man's decrepitude must needs be modified. The evolution of power in matters purely physical is undeniable. In spite of this increase of power, however, the modern man is in many ways a poor creature and unlovable. It is an increase of power by deputy. With his narrow chest, dull ears, near-sighted eyes, and squeaky voice, even his multitudinous apparatus fails to make him comparable with the glorious creature who represented the best product of Greek culture. If our reflection ended here, even Mr. Spencer's very clever suggestion would scarcely make us thankful for an evolutionary process which had given us such doubtful progress. There has been an unquestionable falling off of personal power. The advance has been of the race. But we may believe without undue optimism that this failure of the individual will be but temporary. It is a period of acquisition. We may reasonably hope that this will be followed by a period of expenditure, when the gains of the race will be utilized. To-day, the majority busies itself with the means of living; to-morrow, it may find time to live. The faculties have been sacrificed to the demands of research and mental activity. When these have yielded their harvest, we may look for a wholesome reaction upon the faculties themselves. The knowledge which cost a human life, once gained, will serve a thousand lives. The philosopher whose bent form and bleared eyes bespeak research will be succeeded by a more beautiful generation who utilize his discoveries. Any smaller result would hardly justify the current martyrdom. The coming renaissance will be in the fine art of living.

In this evolution, the materials acted upon have ceased to be simply flesh and blood. The human activity is largely cerebral, while its materials are inanimate. To supply them the three kingdoms of Nature have been ransacked. It is the purpose of the present paper to indicate in a measure the contributions which glass has made to this evolutionary process, for its office is one of increasing importance. In the search for power, the qualities which have given glass so large a value are those particularly of refraction and transparency. These qualities, combined with its hardness and indifference to most chemical reagents, make it one of the most useful of servants in the good cause of science.

First, then, a word in regard to its refractive power.

If a beam of light pass from one medium to another of different density, such as from air to water, its course is not altered, provided the surfaces of the two media be at right angles to the beam. A penny placed in a basin of water looks in no way distorted if the eye be directly above the coin. But when a beam of light passes into a second medium at other than a right angle its course is bent. A straight stick, partly immersed in water, looks crooked because the light reflected from the portion beneath the water is bent on entering the air. The fact is familiar to every one. This bending of the light has received the name of refraction, and its laws are exceedingly simple. If the beam pass into a denser medium, as from air into water, the bending is *toward* the perpendicular to the common surface of the two media. On the other hand, if the passage be into a rarer medium, as from water into air, the beam is bent *away* from the common perpendicular. We may, then, predict in a general way the course of a beam of light when it changes its medium, but in scientific work we must do better than that—we must know the exact course of the beam. This brings us to the second law of refraction, which is quite as simple as the first, but which requires, if one is not mathematically inclined, a trifle more patience for its comprehension. In any angle, if a perpendicular be dropped from any point on one side to the opposite side, the ratio between the perpendicular and the distance of its starting-point from the apex of the angle will evidently be a constant quantity for that angle, wherever the point be taken. This ratio is called the sine of the angle. If one will take the trouble to draw a series of angles from zero to ninety degrees, he will readily see that the value of the sine increases from zero to unity, and that these are its limits.

Now, it is found by experiment that the ratio between the sine of the angle of incidence (the angle which the impinging ray makes with the common perpendicular to the two media) and the sine of the angle of refraction (the angle which the refracted ray makes with the common perpendicular) is a constant quantity. This quantity is known as the index of refraction.

But it may be asked what all this has to do with glass-making. Essayists are prone to talk about evolution and the fourth dimension of space, and many other things which seemingly have no connection with the subject in hand. In this case, however, the wandering is justifiable, for the index of refraction is a constant which must ever be borne in mind by the scientific glass-worker, if he wishes to use the material in the construction of optical instruments. In general, the greater the index of refraction, the more available the glass. The practical question with him is to know the conditions which affect the index of refraction. To answer this intelligently, one must consider why the light is bent at all in changing its medium. If a bather run down a smooth, hard beach into the water, he is very apt to fall head foremost when he reaches the denser medium. His feet are suddenly retarded, while his body keeps on through the air with the old velocity. The result is a change of direction in his motion, which is in one sense disastrous.

Precisely the same thing happens to the light. It is generally conceded to be a progressive wave-motion. When the beam passes into a denser medium at an angle, the side of the beam which enters first is retarded, while the other side keeps on at the old velocity. The result is, that the whole beam is swung out of line and takes a new direction in the new medium. The index of refraction is simply a quantitative expression for this bending, and depends upon the nature of the substance and its density. The great brilliancy of the diamond is due to its very high refractive index, and the sparkle of cut glass is the result of a similar property.

Since the employment of glass in optics depends upon its ability to bend the rays of light to a common point or focus, its value increases with its refractive power—that is to say, with its density. The problem set before the maker of optical glass is, therefore, quite different from that which must be solved by the manufacturer of more every-day goods. He must produce a glass which has great weight without any loss of transparency. The difficulty lies in this, that the substances which add weight to the glass are prejudicial to its transparency. Success is found in the nice balance between these opposing tendencies.

Glass is a double silicate. If it is to have large density, the metallic bases combined with the silica must be heavy. Hence, the ordinary glass of commerce—a double silicate of lime and soda—will not serve in optics. In place of this, a double silicate of lead and potash must be used. The lead gives density to the glass, and consequently high refractive power. The crude materials must be as pure as practicable. To about a hundred parts of sand there is added a mixture of one hundred parts of minium, or red lead, and thirty parts of potash. When these are fused together in large, hooded crucible pots, a very liquid glass results. It is considerably more fusible than the lime-soda glass. So far, the process is easy; but the silicate of lead is so much heavier than the silicate of potash that when the fused mass is allowed to cool the denser silicate has a decided tendency to separate out at the bottom of the crucible. This makes the glass streaky and quite unfit for use. To avoid this settling and secure a clear, homogeneous glass, that is the problem.

At the present time the best optical glass is probably made in France, and the methods there in use are consequently most worthy of examination. During the melting process the crucible is placed in the center of a domed furnace. The flames play around the crucible on all sides, making an intense heat possible. The hood prevents the furnace gases from acting upon the compounds of lead and reducing them to the metallic state. The well-mixed batch is introduced in small quantities into the thoroughly heated crucible, and the charging process continued until the pot is completely filled. This will require from six to ten hours. The heat is then continued for perhaps four hours, at the end of which time the molten glass is vigorously stirred with a wrought-iron rod incased in a fire-clay cylinder. Then comes a second period of quiet heating and a second stirring. After this the stirrings succeed each other at every hour. When these hourly stirrings have been repeated perhaps half a dozen times, the crucible is allowed to cool down for a couple of hours. It is then heated to the utmost that the furnace will permit. As the result of this intermittent treatment, the glass is very liquid and is quite free from bubbles and striations. During the gradual cooling which succeeds this firing, a constant stirring is maintained for at least a couple of hours. When the stirring becomes too difficult, it is discontinued, and crucible and furnace are allowed to cool during a period of ten days or more.

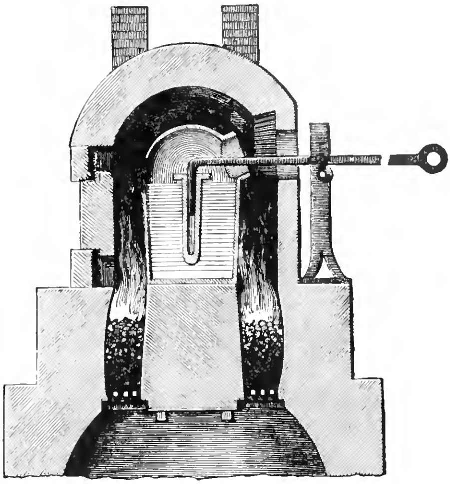

Fig. 1.—Flint-glass Furnace.

The secret of making fine optical glass lies in this stirring. It was first carried out by Guinand, in Switzerland, in the early part of the century, and was introduced in Paris by Bontemps.

When the cooling is accomplished, the crucible is removed from the furnace and broken, so as to free the mass of flint glass which it incloses. In spite of all this care, it must not be supposed that a mass of perfect glass is the result. On the contrary, it is full of flaws and imperfections, and only a part of it can be used. It is customary to grind and polish parallel faces on the side of the mass, so that its defects may be located and the perfect portions utilized to the best advantage. The mass is cut into slabs suitable for working up into prisms, lenses, and other optical instruments.

When a large disk is to be made, such as the great lens of a refracting astronomical telescope, several attempts are frequently necessary before success is gained. Two or even three years may pass before suitable material is cast.

As the result of this very troublesome process, we have slabs of fairly homogeneous glass from 3·4 to 3·6 times as heavy as water. Although the greater density is about equal to that of the diamond, the refractive indices of the two substances are not the same. That of the diamond is 2·5 and of the flint glass 1·61. But even this refractive power is the key to many mysteries. The trouble of producing the material counts as nothing in face of the results.

The possibility of increasing the refractive index of optical glass by increasing the density early attracted the attention of experimenters. Since the beginning of the century attempts have been made in this direction. By the use of the heavier rare metals, such as thallium, a glass has been produced over five times as heavy as water. The material has served admirably for the manufacture of artificial jewels, but has not as yet found permanent application in science.

The refractive power of glass, by which the rays of light are bent out of their course and images of objects formed, has its disadvantages as well as its merits. It is almost impossible to construct a lens which shall converge the rays of light without, at the same time, producing rainbow colors around the image. This defect is called chromatic aberration, and, as one can readily see, is fatal to the definition of the lens. It is commonly overcome by employing a compound lens, made of flint and crown glass. The different refractive indices of the materials correct each other's aberration and produce white light. A lens so constructed is termed achromatic, since it does away with the fringe of color. Loss of power is naturally the price of such a correction. These difficulties led to the project of making lenses out of a material which should obviate the color fringe by something in the glass itself. It is found that titanic and boric acids have a marked effect upon the refraction of the differently colored rays, and compounds of these materials have been used to good purpose. We have here a field well worth further exploration.

The best flint glass for optical use is made in Europe. It is an interesting circumstance that the great establishments of Messrs. Chance and Company, at Birmingham, and M. Feil et Cie.—now M. Mantois—at Paris, which largely supply the Ameri-

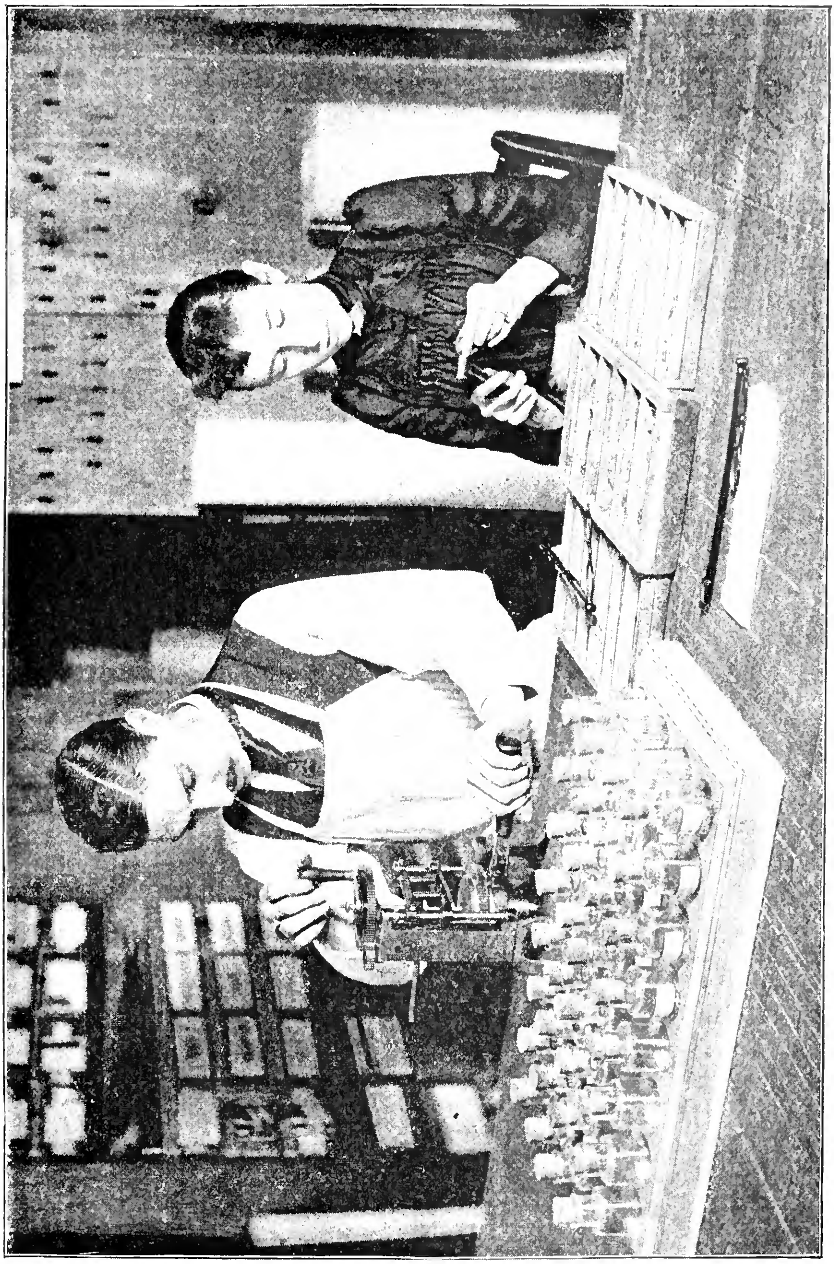

Fig. 2.—Making Spectacle-lenses.

can market, are both, in this department at least, lineal descendants of the persevering Swiss watchmaker, Guinand, to whom we owe the present superiority of optical glass. The material is imported in convenient slabs for use in smaller articles and in rough disks for the larger lenses.

A noted French critic has left on record a touching account of the first time he ever looked through a pair of spectacles. He was terribly near-sighted, but no one had ever given sufficient attention to the defect to make any attempt to remedy it. One day, while still a boy, he got hold of his grandfather's spectacles, and put them on. Great was his surprise to find that the giant tree which shaded his play-ground was made up of individual and beautifully formed leaves instead of being, as he had previously supposed, one almost solid mass of green fóliage. The boy fairly danced with delight, for a new world was suddenly opened to him.

A little fragment of glass, which thus gives sight to the almost blind, must claim attention even before the instrument which discloses either microcosm or macrocosm, for it has to do with the most important of all sciences, the science of daily living. The grinding of the small lenses for spectacles and eye-glasses is carried on in many establishments throughout the country and has been reduced to very accurate practice. Three surfaces are utilized—spherical curves, cylindrical curves, and prismatic faces. Their effect can readily be understood if one will consider for a moment the passage of a beam of light through an ordinary triangular prism. As the light is bent toward the common perpendicular on entering the glass, and away from the common perpendicular on leaving the glass, the total bending will be toward the base, or thicker portion. Now a lens may be considered a double prism; convex, if the two prisms be placed base to base, and concave if they be apex to apex. Since the light is always bent toward the thicker portion, the convex lenses converge the rays while the concave ones disperse them. In designing lenses for spectacles, these principles find application. If the eye be perfectly formed, but have too little or too great convexity, the remedy is found in glasses with simple spherical faces; but if the structure of the eye be faulty and non-symmetrical, as in the astigmatic, the glasses must have cylindrical or prismatic surfaces.

The bit of glass to be formed into a lens is fastened by means of pitch to a small block of hard rubber so that it may be more readily handled. It is ground by being pressed against a rapidly revolving metal tool, whose curvature is equal and opposite to that desired in the lens. This is known as the "rough tool" and is made of cast iron. It is mounted on a vertical spindle, and is kept moistened with emery and water. Several grades of emery are used in succession, changing from coarse to fine as the grinding proceeds. As a result of this process the glass has a rough surface and is no longer transparent. It is now transferred to the "fine tool." This is made of brass and has its surface as true as possible. It is compared from time to time with a standard curve, in order to insure accuracy. In this second grinding the abrading material is rouge (carefully calcined sulphate of iron). Finally, the lens is polished by being pressed against a piece of cloth powdered with rouge and fastened to the rotating tool. The glass is now loosened from its block, turned over, and the reverse side of the lens ground. When this has been accomplished, the lens must be cut down to the proper shape for mounting in the spectacle-frame. It is placed on a leather cushion and held firmly in position by a rubber-tipped arm, while a diamond glass-cutter passing around an oval guide traces a similar oval on the glass below. The superfluous glass outside of the oval is removed by steel pincers, the rough edges are ground smooth on Scotch wheels, and the lens is ready for mounting. The glasses for small telescopes, microscopes, burning-glasses, and the like are ground in the same fashion.

When, however, it comes to grinding the lens for a large astronomical telescope, the process is slightly modified. The work is one requiring considerable skill and patience, though it involves no very great difficulties. It was formerly done entirely by hand and by individual workmen rather than by large firms. It will be remembered that the philosopher Spinoza earned his living by grinding lenses, and since his time less famous workmen have patiently pursued the same trade. At present the grinding of telescope lenses has assumed the proportions of a business, and has nowhere been carried to greater perfection than in America. The firm of Messrs. Alvan Clark and Sons, whose workshops are at Cambridgeport, Mass., have gained a reputation which extends on both sides of the Atlantic, as their lenses exceed in both quality and size even the best products of European skill. A great astronomical telescope is indeed quite cosmopolitan in its genesis. The glass is cast in Paris, the grinding is done in Massachusetts, the mountings are made in London or Berlin, and the telescope itself is pointed toward the heavens from Mount Hamilton or from the Russian Imperial Observatory at Pulkowa.

All the glass ground at Cambridgeport comes from the establishment of M. Mantois in Paris. It is imported in the shape of large disks, which are generally flat on both sides. The first grinding is done by machinery, the abrading material being Tilghman's chilled iron globules. These are found to be more effective than sand. The finer grinding is accomplished by means of varying grades of emery. It is in the finishing process that the American operations take rank over the foreign. The final touches and the polishing are all done by hand, the rouge being applied on the tip of the finger. It is necessary to employ constant tests during the course of the grinding. At first, these are all mechanical and are made with a spherometer. Such tests, however, simply insure accurate curvature, and by their very nature can take no account of irregularities in the texture of the glass. These can only be detected and remedied by means of optical tests. When the preliminary polishing is finished, the lens

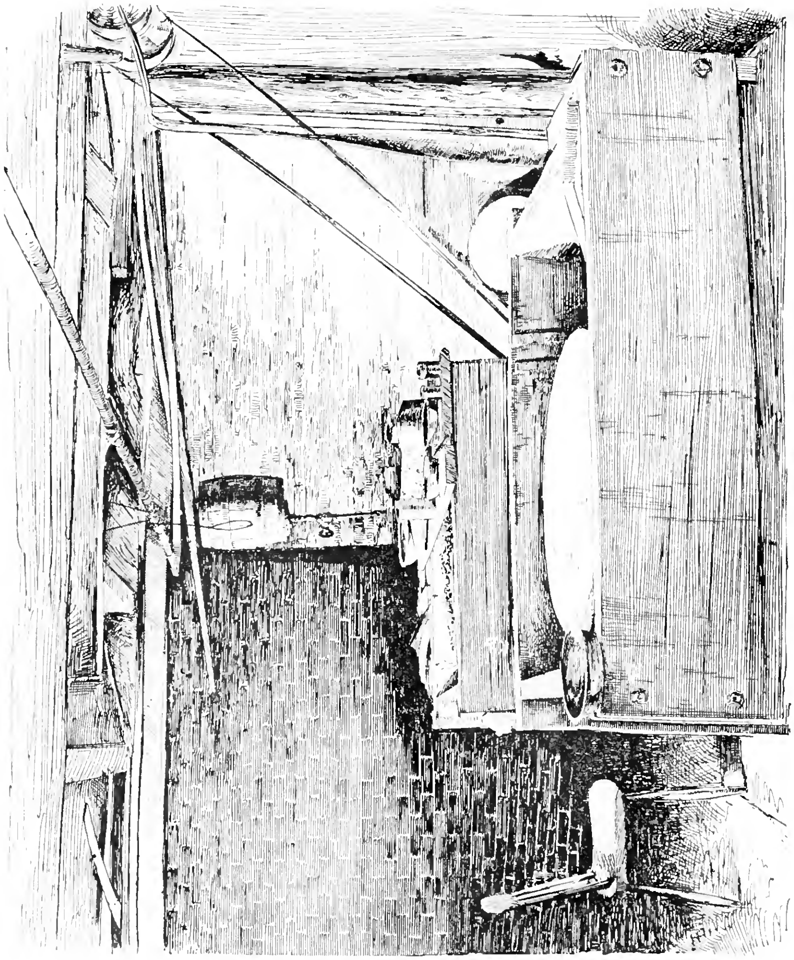

Fig. 3.—Grinding Telescope-lenses.

is roughly mounted and submitted to a most rigid examination. A beam of light from what is called at the workshops an "artificial star" is transmitted through the lens and enables the workmen to locate defects of all sorts. The remedy is then a matter of touch and try, and, as one can readily imagine, is a long and tedious process. Still, the lens is not completed. It must now be submitted to the test of actual star-gazing. The most famous lens turned out by the Messrs. Clark, and indeed the largest in existence, is the one now mounted in the Lick Observatory in California. It has an aperture of thirty-six inches in the clear. It was tested on seventy different nights, on veritable stars, before it was considered finished. It sometimes happens that important astronomical work is done with these temporarily mounted lenses, and some of them have quite a history. Thus, in *ante-bellum* days, an eighteen-inch objective was ground for the University of Mississippi, but, the war coming on, the lens was never sent for. It was afterward used at Chicago, and is now doing good work at Evanston, Ill. While it was temporarily mounted at Cambridgeport, Mr. Alvan G. Clark discovered the companion to the dog-star Sirius, a discovery for which he was awarded the Laland prize by the Imperial Academy of Paris. At the present time a twenty-inch objective for the University of Denver is in progress, while a forty-inch disk of crown glass awaits transformation into a lens for the University of Southern California. It was at first feared that such giant lenses would suffer injury by warping, but the experience at Mount Hamilton has been so reassuring that the present tendency is toward even larger glasses.

It would still be a difficult task, though a less difficult one than the present, if it were simply required to produce a perfect curvature, but the superiority of a lens depends upon its chemical composition as well as upon its geometric form. The problem may be summed up by stating that one must have as homogeneous a material as possible, to start with, and as symmetrical a form as the inequalities in the material will permit, to end with, the theoretical curves being in practice slightly modified to obviate any small irregularities in density.

The crown-glass lens with which the flint glass is combined in order to obtain achromatism is made in the same way, only that the material is a lime-soda silicate similar to that used in window glass instead of having lead and potash as its bases.

It would be easy to multiply illustrations of the use which science makes of the refractive power of glass, as in the stereopticon, the kaleidoscope, the camera, the projecting lantern, and in other apparatus of scientific or popular nature; but in the manufacture of all of them these two principles hold—the production of a heavy, uniform glass, and the shaping of this material into suitable form by processes of grinding and polishing.

There is, however, one application so important to philosophic thinking as to deserve special mention, even though it involves no new principle. What the astronomical telescope has been in the study of the physical features of the heavenly bodies, the glass prism is in the investigation of their chemical constitution. Had one spoken but a few years ago about the chemistry of the sun and stars, and seriously proposed their analysis, his hearers would probably have tapped their foreheads significantly and perhaps even winked at one another. But to-day stellar chemistry is a recognized branch of cosmical research. If a ray of sunlight be passed through a glass prism, it gives a bright, continuous spectrum, varying in color from red to violet. If the source of light be a vapor of a metal, or metallic salt, the continuous spectrum is replaced by one or several bright lines whose position and color are invariable for the same metal. If a more intense white light be allowed to pass through the metallic vapor, the former bright lines appear black, but are easily recognized by their number and position. In the solar spectrum a whole series of such black lines are distinguishable, and by correspondence they are believed to indicate the presence of at least seventeen of our earth elements, while there appears to be at least one element in the solar atmosphere for which we have no counterpart on earth. A similar study of the light of the stars has disclosed in their atmosphere a number of earth elements and has indicated the presence of others unknown on earth. This little piece of flint glass, ground into the shape of a triangular prism, has proved the "open sesame" to secrets so profound that in its absence they must have been regarded as belonging to the great domain of the unknowable. It is something of a triumph for the near-sighted philosopher on our planet to announce that he has discovered magnesium on the star Aldebaran and sodium on Sirius.

While the refractive power of glass opens so many wonderful possibilities, its simple transparency is a quality which adapts it for many less ambitious uses. Much of the work of science is that of measurement. Sir William Thomson has indeed said that in any branch of research we have only so much science as we have mathematics. For this service of measurement, glass is admirably adapted. The measurement of heat by the thermometer is an example of a frequent and important operation, while the manufacture of the instrument itself is a type of many similar processes.

The ordinary thermometer measures heat by the expansion of some such liquid as mercury. The increase in bulk for any slight increment of heat would be too small, however, to be perceptible in a mass of the fluid metal. Hence the necessity for the glass-blower's skill by which the increased volume is made sensible to the eye. By having a comparatively large bulb in connection with a tube of very fine bore, the slightest expansion in the volume of the mercury becomes at once apparent by a relatively large change of level of the fluid in the tube. The greater the discrepancy between the bulb and the tube, the more sensitive the instrument.

The operation of making a thermometer begins in the crucible-pot. The glass-blower dips his blowpipe into the molten mass of glass, withdrawing a small quantity of the material with his pipe. The plastic mass is rolled into a pear-shaped ball on the marvering table. A little air is then blown into the center of the

Fig. 4.—Blowing Thermometer-bulbs.

mass, and a second workman attaches the end of his iron rod or "punty" to the free end of the ball. The blower remains stationary, while the second man walks away from him, carrying his punty with him. In this way the mass of glass is drawn into a long tube, perhaps fifty feet long, the bubble of air preserving a fine opening throughout the entire length of the tube. In the better thermometers, the tube is somewhat flattened, so as to make the thread of mercury more visible, and a background of opaque white glass is added for the same purpose. These modifications are made more easily, perhaps, than one would imagine. By flattening the ball of glass before it is drawn into a tube, the elliptical cross-section is secured, while a string of opaque glass welded on to the still plastic ball becomes elongated into a thin plating on one side of the tube.

It is impossible in this way to secure tubes of absolutely uniform bore, but the inequalities are much less than one would suppose. For ordinary instruments the variation may be neglected. The tubes are then cut into convenient length and sent to the workshop of the thermometer-maker. One can readily pass a whole morning in the little room where he works, for there is a certain interest attaching to so individual a task as this which is not found in more wholesale production. The instrument-maker sits on a high stool before his work-table, his principal tool being a conveniently arranged blowpipe. This is not the hand and mouth tool used by mineralogists and jewelers, but is a permanent blowpipe fed by gas and operated by a blast of air.

The first operation is that of forming the bulb. In the better instruments this is made out of a separate piece of glass and is then attached to the tube. In this case the bulb is made cylindrical in form, so as to afford large capacity without too great diameter. In the less expensive thermometers, the bulb is formed directly on the end of the tube itself. The glass is first fused in the blowpipe flame until the end is entirely sealed. A short rubber hose with a small rubber ball on the opposite end is then slipped over the open end of the thermometer-tube. The sealed end of the tube is again softened before the blowpipe, and then, by simply pressing the rubber ball, the air forces the plastic glass into a symmetrical bulb. It is a pretty little operation, for the glass responds so delicately to the thought of the workman.

It is found that glass undergoes a slow contraction during a period of two or three years, and, where great accuracy is desired, the tube must be put away for that time to season.

The bulb and tube are now to be filled with mercury. The tube is much too fine to allow the mercury simply to be poured into the bulb. Indirect means must be used. The open end of the tube is softened and quickly blown into a large bulb, while the end is drawn into a fine jet. This is hastily plunged beneath the surface of a bath of pure mercury while the whole thermometer is still hot. As it cools, the air inside shrinks and the mercury

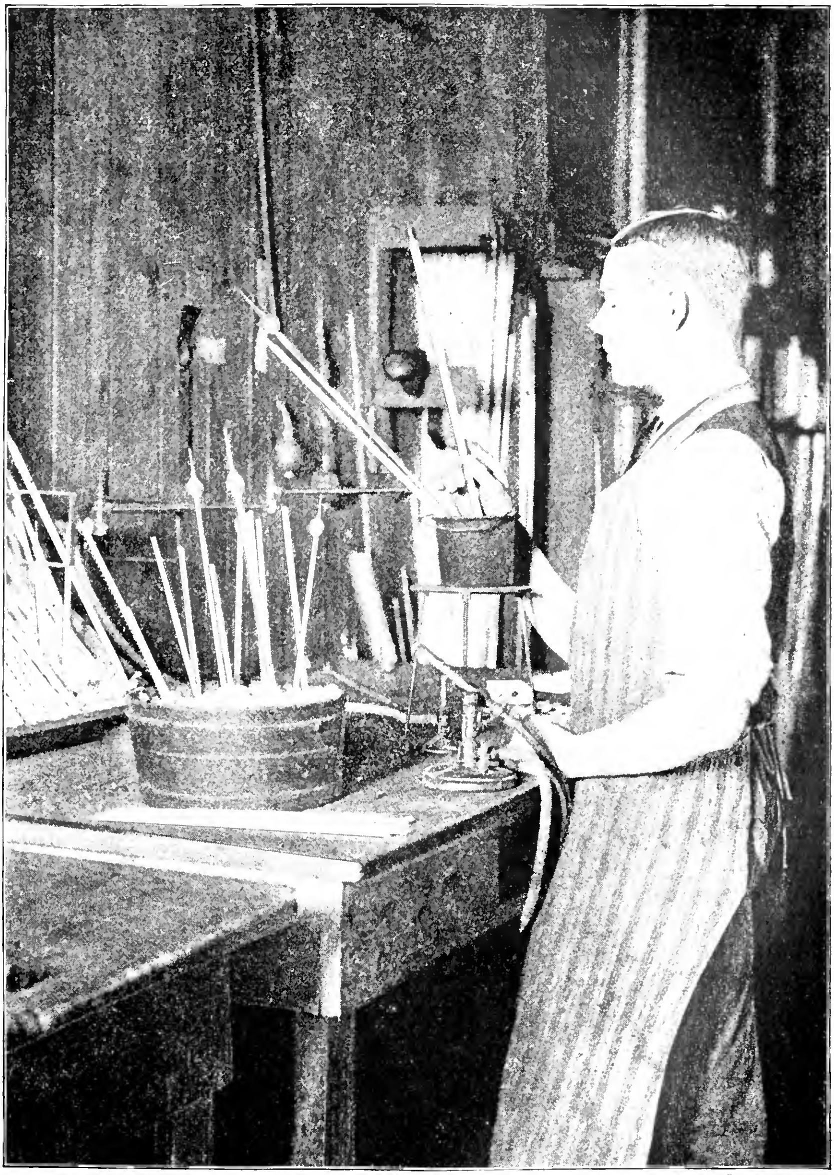

Fig. 5.—Calibrating Thermometers.

rises into the outer bulb. The permanent bulb is then carefully warmed, the tube being in a horizontal position so that the expanding air may freely escape. The tube is then held vertically and allowed to cool. The mercury in this position closes the upper end of the tube, and as the cooling proceeds it is sucked through the capillary opening and falls, drop by drop, into the bulb below. The process is repeated, if necessary, until the lower bulb is filled with mercury. The thermometer is then heated. The mercury expands, driving out all the air and filling both bulb and tube. The temporary bulb is now removed, and the open end of the tube is closed before the blowpipe. The thermometer is ready for calibration.

The bulb is buried in cracked ice, from which the water is allowed free drainage. When the mercury no longer contracts, a mark is made on the tube at a level with the mercury. This is the freezing-point of water, 0° on the centigrade scale, or 32° on the Fahrenheit. Réaumur's scale, with the freezing-point at 0° and the boiling-point at 80°, although so extensively used in Germany and Russia, is seldom seen in this country. The thermometer is then transferred to a bath of boiling water. The mercury quickly rises, and soon again becomes stationary. The tube is marked for the second time. This is the boiling-point of water, 100° centigrade, or 212° Fahrenheit. As the temperature of the boiling-point varies with the atmospheric pressure, the barometer must be read and a corresponding correction made, or else a standard thermometer must be kept in the bath, and the marking made in harmony with that. These two points determined, the operation of making a thermometer is almost completed. It has now only to be marked.

The tube is dipped into a bath of melted beeswax, and as soon as the thin layer of wax hardens it is taken to the dividing-engine. The space between the freezing and boiling points is here divided off into 100 divisions if the centigrade scale is to be employed, or into 180 divisions if the Fahrenheit be used. Every tenth line is made somewhat longer than the others, and is the only one marked. The marking is done on a machine constructed after the order of a pantograph. The waxed tube is laid on a small sliding platform and secured to its bed by a few drops of melted wax. A sharp stylus is then brought to bear upon the point where the marking is first wanted. The movement of the stylus is controlled by a long lever, whose own movement is, in turn, controlled by the action of a second stylus. This is made to pass over the desired figures cut in brass on a lower platform of the machine. The action of the system of levers is to reduce the motion of the upper stylus, and consequently the size of the figures traced through the wax. In this way accurate marking is secured on a sufficiently small scale. The tube, thus lined and marked, must now be subjected to the action of hydrofluoric acid. A solution of the acid in water, to which some alkaline salt has been added, is rubbed over the tube. In a few moments the glass is sufficiently bitten. The tube is washed with water and the wax removed. The lines and figures are then blackened with varnish, and the thermometer is ready for use.

It must not be supposed that the same care is employed in the

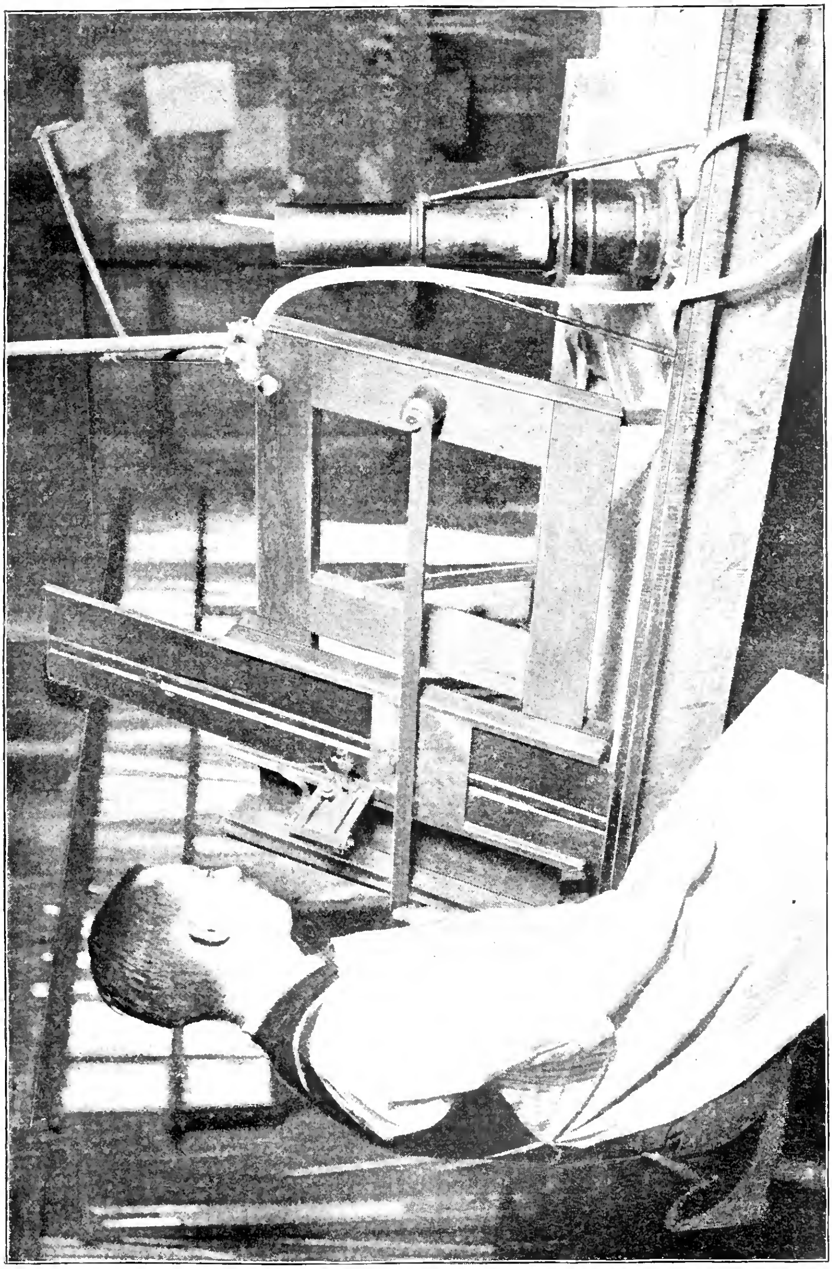

Fig. 6.—The Dividing-engine.

construction of the ordinary instruments sold in the shops for domestic usage. Their low price would preclude that. They are made in large quantities, and their calibration is only approximate. They have been known to be as much as six or eight degrees out of the way; but that is much worse than the average. After one has watched the construction of a scientific thermometer, he wonders not that they should cost a couple of dollars or more, but rather that they can be sold at such a price.

For many purposes, such as the systematic observation of the weather, it is desirable to have thermometers which shall register the highest and lowest temperature reached. These maximum and minimum instruments require additional care on the part of the thermometer-maker. In the latest pattern manufactured for the Signal Service a decided improvement has been made in the self-registering device for maximum temperatures. The bore of the tube is greatly contracted at a point somewhat below the lowest reading that will probably be required, and the thermometer is usually placed in a horizontal position. Under the action of an increasing temperature, the mercury expands and forces itself through the very narrow opening. But when the temperature falls, the mercury will not pass through this opening, and all the shrinkage of the fluid in the bulb takes place below the contraction. As a consequence, the column of mercury remains stationary, and so records the highest temperature reached. By vigorous shaking the instrument is readily reset.

In the thermometer for registering the lowest temperature colored alcohol replaces mercury. A little rider of glass is so trimmed with fine hairs at each end that, while it does not fit in the tube with sufficient snugness to prevent its being pushed down the tube by the retreating meniscus at the surface of the alcohol, it will become wedged in place when the column ascends.

The special feature to be noticed in the manufacture of the thermometer is the individuality of the process. Each instrument is the subject of a separate operation. The same principle is applied in the manufacture of barometers and hydrometers. In the fabrication of the first, a glass tube is simply closed at one end and then filled with pure mercury, from which all the air has been expelled by boiling. Its subsequent marking and adjustment in a suitable frame are only matters of careful handling.

In the fabrication of hydrometers more special work comes in. The transparency of the material is not here an essential feature, although it is utilized and the graduation placed inside of the tube. The quality which renders glass particularly available for this service is its indifference to chemical reagents and its constant weight. The principle upon which hydrometers are constructed is familiar to all. In order that an object may float, it must displace its own weight of the supporting fluid. If, then, a float of invariable weight be immersed in a liquid, the depth to which it sinks will be a measure of the specific gravity of the

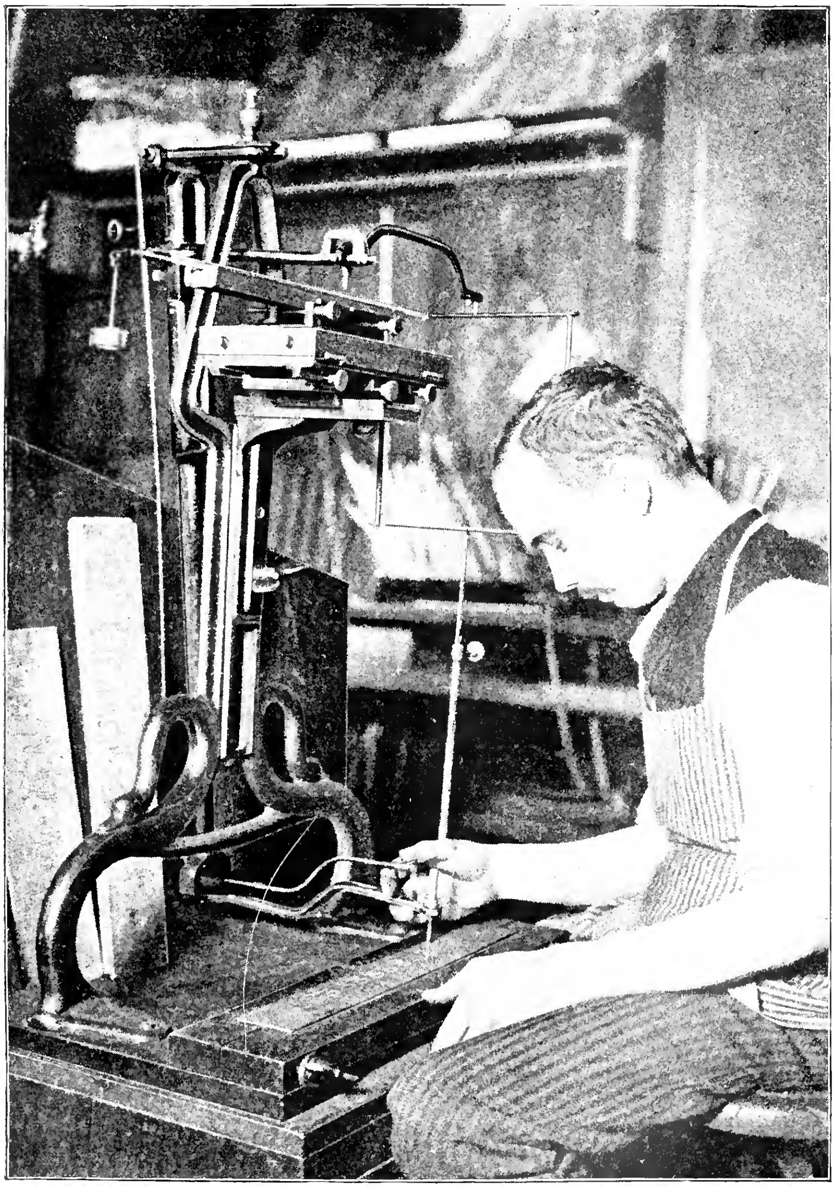

Fig. 7.—Marking Thermometers.

liquid. The hydrometer is simply such a float as this. It is made in different forms and styles, according to the use for which it is intended; but in all cases it is essentially a cylinder or bulb of glass, loaded at the bottom with either mercury or shot, and terminating above in a slender, graduated tube. The weight of the metal so lowers the center of gravity that the instrument always floats in a vertical position. A suitable length of plain

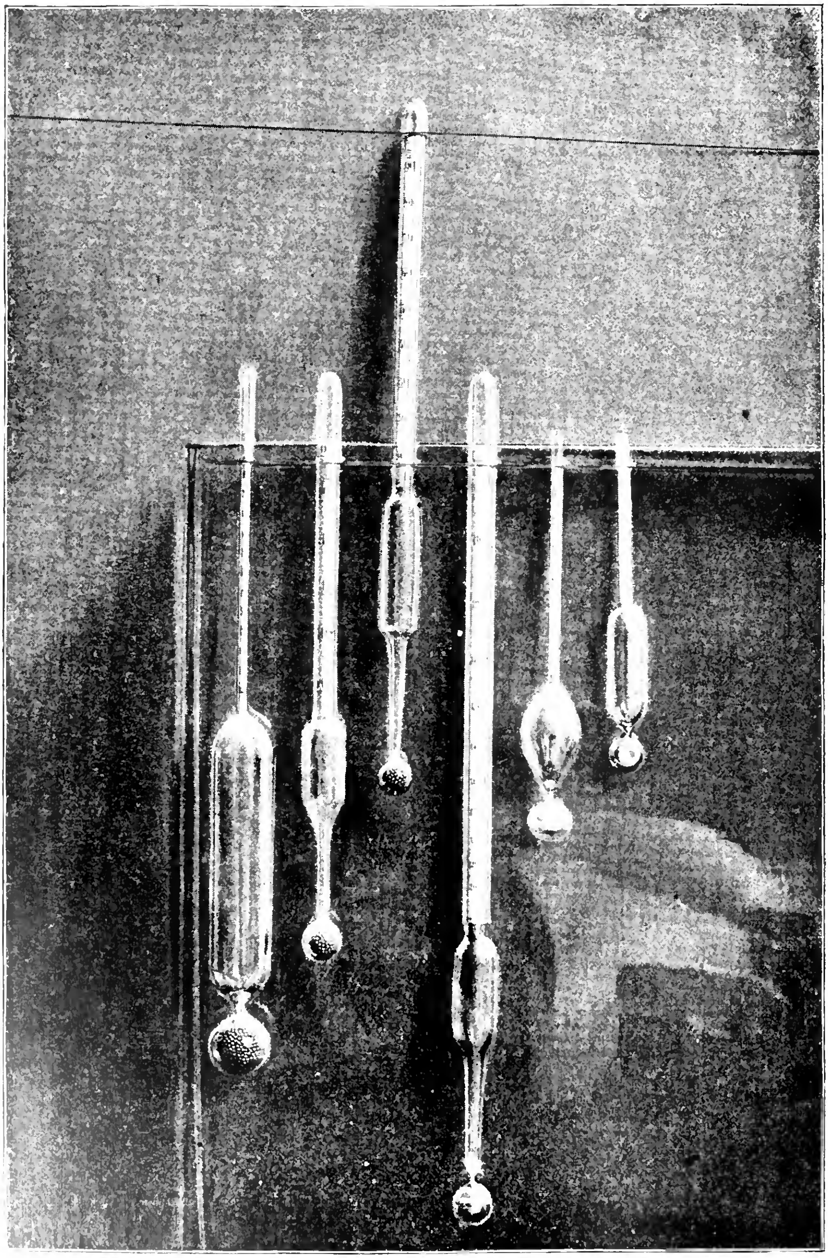

FIG. 8.—VARIOUS FORMS OF HYDROMETERS.

glass tubing is taken by the glass-blower and sealed at one end. A bulb is then formed for the reception of the ballast, and the upper end is drawn out into a smaller tube. Mercury or shot is then added until the instrument floats in an upright position. It is placed in pure distilled water at 60° Fahrenheit. If the hydrometer is to be used for measuring the specific gravity of liquids heavier than water, it is loaded until the level of the water almost reaches the top of the tube. The instrument is then placed in a second heavier liquid of known specific gravity. It will come to rest farther out of the fluid than before, since it must needs displace less in order to float. This second point established, it is easy to construct the scale. If the hydrometer is to be used for liquids lighter than water, let us say for alcohol, it is so loaded that when placed in pure water the level will only reach up to the lower part of the tube. It is then placed in a lighter liquid of known specific gravity. It will sink lower in this case, since it must needs displace more of the fluid in order to float. This second point established, it is an easy matter to continue the graduation upward in space and downward numerically. The scale employed depends upon circumstances. In the direct-reading hydrometers, the point to which the instrument sinks in pure water is marked one, and the other readings express directly the specific gravity of the fluid into which it is plunged. In others, the scale is empirical—that is to say, the degrees bear no relation to actual specific gravities. In certain manufacturing processes such scales are used with the purpose of keeping trade secrets. Where the hydrometer is for a special use, such as measuring the specific gravity of alcohol, it is known as an alcoholometer, and the marking ascends from pure water at the bottom of the graduated tube to pure alcohol at the top. The degrees give at once the percentage of alcohol in the liquid under examination. One of the most familiar special forms is the lactometer, the hydrometer used for measuring the specific gravity of milk. The scale is commonly drawn on a piece of paper which is fastened inside the tube in the right position. The end is then sealed before the blowpipe, and the instrument is ready for use.

The manufacture of pressure-gauges and other glass instruments for measurement proceeds in much the same fashion.

In chemical and physical laboratories the use of glass instruments is a simple necessity. Combustion-tubes, beakers, funnels, test-tubes, watch-crystals, burettes, pipettes, absorption bulbs, bell-jars, flasks, apparatus for electrolytic decompositions, and a hundred other essential articles could scarcely be made of any other material. Here the transparency of the glass, its great strength, and its almost total indifference to the action of reagents give it special suitableness. The principles involved in the manufacture of these objects are simply ingenious modifications of those involved in processes already described. Most of the scientific apparatus in glass is brought from Thuringia. Our own workmen do not seem to have that turn for science which is shown by the Germans. Even the little apparatus which is made in this country is for the most part the work of foreign artisans.

It would be a grave omission to close even so brief a summary of the office served by glass in science without calling attention in a few words to one of the latest and most interesting lines of research which it has made possible. We refer, of course, to the vacuum tubes employed by Mr. Crookes in his well-known investigations into the properties of radiant matter. We have been ac-

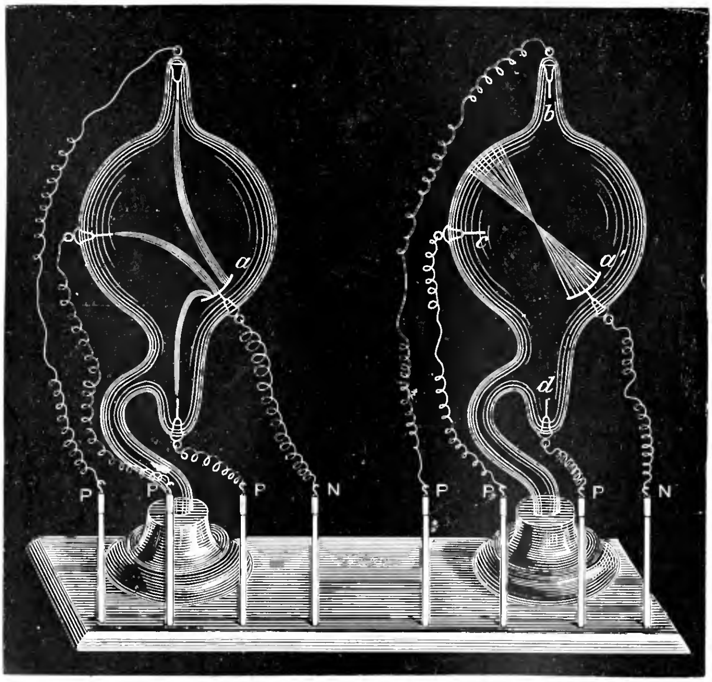

Fig. 9.—Vacuum Tubes

customed to talk somewhat glibly about the three states of matter. To this list we are now asked to add a fourth, the radiant. Faraday's hint and the work of Mr. Crookes have well-nigh established the distinction between gas and radiant matter. In a gas under ordinary tension the molecules are in sufficient number to suffer almost constant collision with one another; but if the tension be low enough, say the one five-millionth of an atmosphere, the collisions become infrequent, and the molecules travel in almost uninterrupted straight lines until they come into contact with the sides of the containing vessel. For this state of matter the term *radiant* seems at once appropriate and happy, for matter so attenuated exhibits phenomena apparently entitling it to a separate class and name. The radiant-matter tubes are simply bulbs or cylinders of glass several inches long and perhaps three or four inches in diameter, which contain only the most minute traces of gaseous matter. Metallic terminals for electric connection are sealed into the glass. These are given various shapes and positions, so that the behavior of radiant matter under different conditions may be observed. The manufacture of radiant-matter tubes is a work of dexterous glass-blowing. In the simpler forms a plain cylindrical tube is taken as the basis, and is sealed at one end. After the electrodes have been put in place, the other end is drawn into a fine tube, which is also sealed as soon as the exhaustion has been accomplished. Some of these tubes have been made experimentally in this country and more in England, but the home of this industry is also to be found in the Thüringer Wald. They deserve special mention in this connection, since no other material than glass would serve for such investigations.

The philosopher was formerly represented as a seated figure in a gown, and surrounded by hour-glass and old folios. To-day he is more active. He is better pictured in a blouse, and standing, surrounded with the apparatus of science. In his search for power he has brought new material to his service, and none of greater value than that which enables him to study distant globes, to investigate the inner history of an infinitesimal world, to find out the chemistry of the stars, and to pry into the properties and constitution of matter. But he stands there not in pride. The figure is one which breathes a deep humility. Each victory over the unknown only makes him the more sensible of the infinite world beyond his present vision. The office of science is corrective and disciplinary. It teaches one of its deepest lessons when it opens the eyes to the recognition of that which is unseen. The evolution of true power is the evolution of a spiritual insight which, in perceiving the known, perceives also the existence of something beyond. The greatest service of glass lies not in the definite knowledge which it brings us, but rather in the stimulating possibilities which this knowledge suggests.

THE result of Mr. Horatio Hale's examination of the subject, communicated by him to the International Congress of Americanists, is that "so far as our present knowledge extends, the theory that would trace the origin of the population of America, or any portion of it, to the Polynesian race, finds no countenance in the testimony of language, and is made extremely improbable by the very recent appearance of that race in the eastern Pacific islands."

SCHOOLS FOR THE INSANE.

By CHARLES W. PILGRIM, M. D.

THE teaching of the insane is by no means a new idea. Early in the history of the Utica Asylum Dr. Brigham made the experiment of having winter classes, and wrote in his annual report for 1844 of the great advantages resulting therefrom. These classes, however, were not long continued, and, if I mistake not, a like history was enacted in the Northampton Lunatic Asylum, where Dr. Earle, our oldest American alienist, instituted a similar work at about the same time. Dr. Kirkbride, another pioneer in American asylums, advocated the education of the insane; but, instead of having organized schools, he had what were known as "companions," who visited the patients in different wards and gave them instruction by reading and conversation. I know, however, of no single attempt in this direction in any of the American asylums which was at all prolonged, and, with one exception, the result was the same with the experiments which were made from time to time in various parts of Great Britain and the Continent. The exception was the Richmond District Lunatic Asylum in Dublin, where Dr. Lalor's zeal and energy elaborated the idea and made of it such a success that his asylum became known on account of its school to alienists in the most distant parts of the world. In 1885, when the school had been in successful operation for about thirty years, I had the pleasure of spending three days with the venerable old man, who is justly called the "father of the school system." He has since laid down the burden of life, but the system which he inaugurated still lives, and is carried on under the direction of his successor.

At the time of my visit there was a daily average of about four hundred and fifty men, and, as the two departments of the asylum are conducted practically in the same manner, I shall confine myself to a description of the male division and its school. About forty of the four hundred and fifty men were in the hospital ward and took no part in the school exercises. Of the remainder, eighty-five were engaged during the day in the garden and various industrial occupations, but about seventy of them attended school on three evenings in the week for an hour after supper. A little more than a hundred were occupied solely in masonry, farm-work, tailoring, basket-making, shoemaking, etc., and more than two hundred were occupied during the greater part of the day with the school exercises. It will thus be observed that nearly every patient in the asylum, excepting those in the hospital department who were physically incapacitated, was engaged either in the school or industrial exercises, and that seventy were engaged in both. It is true that quite a number of the patients whom I saw were too demented to take a very active interest in the exercises, but it certainly seemed to me that constant effort in this direction could not fail to produce a beneficial effect by infusing a spirit of order among the patients, even if it did nothing more. Object-teaching was the plan most in favor among the more stupid ones. For instance, a piece of India rubber would be handed to one of the class, the teacher asking him at the same time to name it; he would then ask its color, shape, and qualities, getting the patients, by experiment, to find out that it was tough, smooth, opaque, pliable, etc., finally ending by questions as to its uses. Some other object, as a piece of glass, would then be taken up until the time allotted for the exercise in that particular way was exhausted. On one or two occasions the Irishman's natural wit could not be restrained. As, for instance, when one was asked in regard to the most important uses of glass, he replied, for "making whisky-tumblers, sir"; and another, when asked in regard to another object, said, "Sure, you know, sir, without asking me to tell you." The more advanced pupils were instructed in reading, writing, arithmetic, and geography. Music occupies a most important place in the system, and I was told that, when a patient's attention could not be gained in any other way, it was frequently possible to get him interested in the singing-class, and afterward in the other classes. The singing is accompanied with instrumental music. Even the theory of music is not neglected, a portion of the daily singing half-hour being devoted to practicing the scale. It should be mentioned in this connection that music also exerts an important influence in another direction, as it naturally leads to drilling and marching, and by placing the less active patients here and there in the line even the most inert can be induced to take part in the exercises, and thus obtain an amount of physical training which it would be difficult to give them in any other way. A number of patients also act as monitors, keep records, etc. The object of the school as formulated by Dr. Lalor is, first, to provide occupation for a large class who otherwise would be unemployed; secondly, to vary the occupation of the patients; thirdly, to apply a system of education to the relief of mental disorders; and, fourthly, to promote the happiness and welfare of all the inmates.

I have visited a large number of asylums in various parts of the world, and I am sure that I have never seen any in which there was better discipline and order among the patients. Like all Irish asylums, the wards of the Richmond District Asylum were poorly furnished, and they lacked many of the features which characterize our sometimes palatial institutions. But, though cheerless in other respects, there were cheap harmonicums even in the most disturbed wards; and, although they were little better than our street hand-organs, it seemed to me that they served a far better purpose than the solitary grand piano which is only seen in the convalescent wards of our State institutions. There were signs of activity everywhere, and a gratifying absence of that gloomy monotony which is so apt to pervade asylum life. The other Irish asylums which I visited were in marked contrast to this; and there was nothing, so far as I could observe, to account for the superiority of the latter, save the school system so energetically pursued.

In proof of the old adage that history repeats itself, the experiment that was tried in the Utica Asylum nearly half a century ago was again taken up some three years since. A similar revival of interest in this subject also took place in two or three other American asylums. In Utica, a small class for the men, with a recovered patient as teacher, was first organized, two hours in the morning being devoted to the teaching of the simpler branches. Such was its success that another class was soon formed for the instruction of the women. The next winter the school was again opened, and it is now in its third year of successful working; and the interest maintained is so great that it is at times difficult to find places in the school-room for all who wish to attend.

The female department of the school (the one to which I shall confine my description) is in charge of an experienced teacher, who is assisted by three patients. Two are melancholiacs who have delusions of a depressing character, and one frequently makes the ward doleful with her moans. The third has the delusion that she is the wife of a prominent physician in a distant part of the State, and insists upon being called by his name. All three, however, manage to keep their delusions in abeyance, and appear to quite forget them while engaged in their work. The population of the women's wards is a little above three hundred, and of this number about seventy are enrolled as members of the school. The average attendance is about fifty. This number could be greatly increased; but, as the school-room is small, only selected cases, and those who are particularly anxious to become pupils, are allowed to attend. The session is held between the hours of ten and twelve in the morning. The teacher first reads a chapter from the Bible, the question of the Bible in the school not being a disputed one in this particular instance; the pupils then repeat the Lord's prayer in unison, and afterward unite in singing one of the gospel songs. The books are not taken from the school-room; the lessons are given out, and about a quarter of an hour is allowed for their preparation.

The school is divided into three sections—advanced, intermediate, and primary. The advanced course consists of geography and historical reading, and is in charge of one of the patients. In the intermediate division, arithmetic as far as percentage, reading, geography, and grammar are taught; it is in charge of two other patients. The primary division, contrary to the general rule, is in charge of the schoolmistress, and the pupils are taught to read, spell, write numbers, and do easy sums. No two in this division are equally advanced, and its successful working requires a large amount of tact and exhaustless patience. At first this department was in charge of the patients, but experience has shown that the pupils get along much better under the more experienced instruction of the head of the school. The pupils range in age from fourteen to seventy-seven. Preference, however, is given to the younger ones who desire to attend, more than half being under forty, nearly one third under thirty, and about one eighth under twenty years of age. They suffer from the various forms of mental trouble, but here again preference is given to those who have melancholia and the more acute forms of insanity. Chronic cases are not excluded, however, and among those who can receive no benefit save the two hours' daily relief from the monotony of asylum life are two Virgin Marys, one queen of the world, one daughter of ex-President Cleveland who is nearly seventy years of age, two who imagine that they have passed from the scenes of earth and dwell among the dead, and one who has the curious delusion that people are constantly walking upon her fingers. As curable cases, and those most likely to recover, are the ones who generally attend the school, the direct curative influences can not be accurately estimated; but, as might be expected, the most encouraging results are met with in the young and in those whose insanity has been of comparatively short duration. I can recall two cases where the patient could not read or write before becoming insane, but became fairly proficient in both before returning home. Three others also occur to me who appeared to be in the depths of dementia, but were, after several days of patient trial, made to feel an interest in a "puzzle map," and each went on uninterruptedly to recovery and home. Another patient is the terror of the ward, in which she stays until ten o'clock in the morning, when she goes quietly to school and remains for two hours one of the most interested of them all. After leaving the school she again becomes ugly and irritable, and it is only the fear of being kept away from it that makes her at all controllable. Surely these scattered instances show results sufficient to justify the efforts made; but I am sure that, even where the results are not so marked, the school is at least an important adjunct to employment, games, out-of-door exercise, and amusements.

All alienists are now agreed that occupation, no matter what form it may assume, is one of the most important measures in the treatment of the insane; and, if the school does nothing more, it fills out a portion of the day, relieves to some extent the tedium of asylum life, and turns for a time at least the patient's morbid thoughts into healthier channels. Pascal says: "Whence comes it that this man who has lately buried his only son, and who this morning was so full of lamentation, at present seems to have forgotten all? Be not surprised," he replies; "he is altogether taken up with looking which way the stag will turn which his hounds have been pursuing so hotly for the past six hours. He needs no more. However full of sadness a man may be, he is happy for the time if you can only get him to enter into some diversion."

The same writer also says, "Without diversion no joy, with diversion no sorrow"; and if this be a truth applicable to the sane, who will doubt that it applies with equal force to those of unsound mind?

The treatment pursued in cases of bodily disease has been not inaptly used to illustrate this system. To deprive the stomach altogether of food in case of trouble in that organ would be fatal; instead, by administering suitable foods, varied, simple, and in limited quantities, we may overcome the disease and bring about a healthy condition; so, too, in disease of the brain, if intellectual food be given in suitable quantity and form, why should we not expect equally good results?

While I would not exaggerate the importance of this system, my experience leads me to believe that much is to be expected from its conscientious and persistent use, and I would fain hope that the time is not far distant when, in every well-organized hospital for the insane, a school will be considered one of the essential features in "ministering to the mind diseased."

Some novel instances of intelligence and human-like traits in animals have recently come under our notice. A terrier dog at Yverdon, Switzerland, pays regular visits at Lausanne, going over and returning by train, and always getting out at the right stations. A cat at Montreux, which can open doors, heard another cat outside mewing to get in. No one answering the request, it rose from the chair on which it was sleeping, walked across the room to the door, opened it, and let its friend in. A tow-horse on a Boston street car, when his turn to work is about to come, quietly drops back behind his fellows, so as to be last in the line and evade the work he was to do. A horse, stabled with his mate and a third horse, stole hay from the stranger to give to his mate, while he was contented with the ration that had been allotted him; and a horse in a team, nibbling some rich grass on his side, gave at intervals mouthfuls of it to his companion, which could not reach it.

THE LIMITS OF STATE-DUTIES.*

By HERBERT SPENCER.

OF the many reasons for restricting the range of governmental actions, the strongest remains to be named. The end which the statesman should keep in view as higher than all other ends, is the formation of character. And if there is entertained a right conception of the character which should be formed, and of the means by which it may be formed, the exclusion of multiplied State-agencies is necessarily implied.

"How so?" will doubtless be the exclamation of many. "Is not the formation of character the end to which much of the legislation we advocate is directed? Do we not contend that an all-important part of the State's business is the making of good citizens? and are not our school-systems, our free libraries, our sanitary arrangements, our gymnasia, etc., devised with the view of improving their natures?"

To this interrogative reply, uttered with an air of astonishment and an implied conviction that nothing remains to be said, the answer is that everything depends on the goodness of the ideal entertained and the appropriateness of the appliances for realizing it; and that both of them are radically wrong.

These paragraphs sufficiently indicate the antagonist views to be here discussed. Let us now enter on the discussion of them systematically

Upward from hordes of savages to civilized nations, countless examples show that to make an efficient warrior preparation is needed. Practice in the use of weapons begins in boyhood; and throughout youth the ambition is to be a good marksman with the bow and arrow, to throw the javelin or the boomerang with force and precision, and to become an adept in defense as well as in attack. At the same time speed and agility are effectually cultivated, and there are trials of strength. More relevant still to the end in view comes the discipline in endurance; sometimes going to the extent of submission to torture. In brief, each male of the tribe is so educated as to fit him for the purposes of the tribe—to fit him for helping it in maintaining its existence, or subjugating its neighbors, or both. Though not a State-education in the modern sense, the education is one prescribed by custom and enforced by public opinion. That it is the business of the society to mold the individual is asserted tacitly if not openly.

With that social progress which forms larger communities

* From Justice, being Part IV of the Principles of Ethics, now in press of D. Appleton & Co.

regularly governed, there goes a further development of State-education. Not only are there now deliberately cultivated the needful strength, skill, and endurance, but there is cultivated that subordination which is required for the performance of military evolutions, and that further subordination to leaders and to rulers without which the combined forces can not be used in the desired ways. It is needless to do more than name Greece, and especially Sparta, as exemplifying this phase.

With this practice went an appropriate theory. From the belief that the individual belonged neither to himself nor to his family but to his city, there naturally grew up the doctrine that it was the business of his city to mold him into fitness for its purposes. Alike in Plato and in Aristotle we have elaborate methods proposed for the due preparation of children and youths for citizenship, and an unhesitating assumption that in a good State, education must be a public business.

Evidently, then, while war is the chief business of life, the training of individuals by governmental agency after a pattern adapted to successful fighting, is a normal accompaniment. In this case experience furnishes a tolerably correct ideal to be aimed at, and guidance in the choice of methods productive of the ideal. All free men have to be made as much as may be into military machines, automatically obedient to orders; and a unifying discipline is required to form them. Moreover, just as in the militant type the coercive system of rule which regimentation involves, spreads from the fighting part throughout the whole of the ancillary parts which support it; so, there naturally establishes itself the theory that not soldiers only, but all other members of the community, should be molded by the government into fitness for their functions.

Not recognizing the fundamental distinction between a society which, having fighting for its chief business, makes sustentation subordinate, and a society which, having sustentation for its chief business, makes fighting subordinate, there are many who assume that a disciplinary policy appropriate to the first is appropriate to the last also. But the relations of the individual to the State are in the two cases entirely different. Unlike the Greek, who, not owning himself was owned by his city, the Englishman is not in any appreciable degree owned by his nation, but in a very positive way owns himself. Though, if of fit age, he may on great emergency be taken possession of and made to help in defending his country; yet this contingency qualifies to but small extent the private possession of his body and the self-directing of his actions.

Throughout a series of chapters we saw that the progressive establishment by law of those rights which are deduced by ethics, made good the free use of himself by each individual, not only against other individuals but, in many respects, against the State: the State, while defending him against the aggressions of others, has in various directions ceased to aggress upon him itself. And it is an obvious corollary that in a state of permanent peace this change of relation would be complete.

How does this conclusion bear on the question at issue? The implication is that whereas the individual had to be molded by the society to suit its purposes, the society has now to be molded by the individual to suit his purposes. Instead of a solidified body-politic, wielding masses of its units in combined action, the society, losing its coercive organization, and holding together its units with no other bonds than are needed for peaceful co-operation, becomes simply a medium for their activities. Once more let me emphasize the truth that since a society in its corporate capacity is not sentient, and since the sentiency dwells exclusively in its units, the sole reason for subordinating the sentient lives of its units to the unsentient life of the society, is that while militancy continues the sentient lives of its units are thus best preserved; and this reason lapses partially as militancy declines, and wholly as industrialism becomes complete. The claim of the society to discipline its citizens disappears. There remains no power which may properly prescribe the form which individual life shall assume.

"But surely the society in its corporate capacity, guided by the combined intelligences of its best members, may with advantage frame a conception of an individual nature best fitted for harmonious industrial life, and of the discipline calculated to produce such a nature?" In this plea there is tacitly assumed the right of the community through its agents to impose its scheme—an assumed right quite inconsistent with the conclusions drawn in foregoing chapters. But not here dwelling on this, let us ask what fitness the community has for deciding on the character to be desired, and for devising means likely to create it.

Whether the chosen ideal of a citizen, and the chosen process for producing him, be good or bad, the choice inevitably has three implications, any one of which condemns it.

The system must work toward uniformity. If the measures taken have any effect at all, the effect must in part be that of causing some likeness among the individuals: to deny this is to deny that the process of molding is operative. But in so far as uniformity results advance is retarded. Every one who has studied the order of nature knows that without variety there can be no progress—knows that, in the absence of variety, life would never have evolved at all. The inevitable implication is that further progress must be hindered if the genesis of variety is checked.

Another concomitant must be the production of a passive receptivity of whatever form the State decides to impress. Whether submissiveness be or be not part of the nature which the incorporated society proposes to give its units, it can not enforce its plans without either finding or creating submissiveness. Whether avowedly or not, part of the desired character must be readiness in each citizen to submit, or make his children submit, to a discipline which some or many citizens determine to impose. There may be men who think it a trait of high humanity thus to deliver over the formation of its nature to the will of an aggregate mostly formed of inferior units. But with such we will not argue.

One further necessary implication is that either there exists no natural process by which citizens are in course of being molded, or else that this natural process should be superseded by an artificial one. To assert that there is no natural process is to assert that, unlike all other beings, which tend ever to become adapted to their environments, the human being does not tend to become adapted to his environment — does not tend to undergo such changes as fit him for carrying on the life which circumstances require him to lead. Any one who says this must say that the varieties of mankind have arisen without cause; or else have been caused by governmental action. Any one who does not say this must admit that men are in course of being naturally adjusted to the requirements of a developed social state; and if he admits this, he will hesitate before he asserts that they may be better adjusted artificially.

Let us pass now from these most abstract aspects of the matter to more concrete aspects.

It is decided to create citizens having forms fit for the life of their society. Whence must the conception of a fit form be derived? Men inherit not only the physical and mental constitutions of their ancestors, but also, in the main, their ideas and beliefs. The current conception of a desirable citizen must therefore be a product of the past, slightly modified by the present; and the proposal is that past and present shall impose their conception on the future. Any one who takes an impersonal view of the matter can scarcely fail to see in this a repetition, in another sphere, of follies committed in every age by every people in respect of religious beliefs. In all places and in all times, the average man holds that the creed in which he has been brought is the only true creed. Though it must be manifest to him that necessarily in all cases but one, such beliefs, held with confidence equal to that which he feels, are false; yet, like each of the others, he is certain that his belief is the exception. A confidence no less absurd, is shown by those who would impose on the future their ideal citizen. That conceived type which the needs of past and present times have generated, they do not doubt would be a type appropriate for times to come. Yet it needs but to go back to the remote past, when industrial life was held contemptible and virtue meant fortitude, valor, bravery; or to the less remote past when noble meant high-born while laborer and villein were equivalents; or to the time when abject submission of each grade to the grade above was thought the primary duty; or to the time when the good citizen of every rank was held bound to accept humbly the appointed creed; to see that the characters supposed to be proper for men were unlike the characters we now suppose proper for them. Nevertheless, the not-very-wise representatives of electors who are mostly ignorant, are prepared, with papal assumption, to settle the form of a desirable human nature, and to shape the coming generation into that form.

While they are thus confident about the thing to be done, they are no less confident about the way to do it; though in the last case as in the first, the past proves to them how utter has been the failure of the methods century after century pursued. Throughout a Christendon full of churches and priests, full of pious books, full of observances directed to fostering the religion of love, encouraging mercy and insisting on forgiveness, we have an aggressiveness and a revengefulness such as savages have everywhere shown. And from people who daily read their bibles, attend early services, and appoint weeks of prayer, there are sent out messengers of peace to inferior races, who are forthwith ousted from their lands by filibustering expeditions authorized in Downing Street; while those who resist are treated as "rebels," the deaths they inflict in retaliation are called "murders," and the process of subduing them is named "pacification."

At the same time that we thus find good reason to reject the artificial method of molding citizens as wrong in respect alike of end and means, we have good reason to put faith in the natural method—the spontaneous adaptation of citizens to social life.

The organic world at large is made up of illustrations, infinite in number and variety, of the truth that by direct or indirect processes the faculties of each kind of creature become adjusted to the needs of its life; and further, that the exercise of each adjusted faculty becomes a source of gratification. In the normal order not only does there arise an agent for each duty, but consciousness is made up of the more or less pleasurable feelings which accompany the exercise of these agents. Further, the implication is that where the harmony has been deranged, it gradually re-establishes itself—that where change of circumstances has put the powers and requirements out of agreement, they slowly, either by survival of the fittest or by the inherited effects of use and disuse, or by both, come into agreement again.

This law, holding of human beings among others, implies that the nature which we inherit from an uncivilized past, and which is still very imperfectly fitted to the partially civilized present, will, if allowed to do so, slowly adjust itself to the requirements of a fully civilized future. And a further implication is that the various faculties, tastes, abilities, gradually established, will have for their concomitants the satisfactions felt in discharging the various duties social life entails. Already there has been gained a considerable amount of the needful capacity for work, which savages have not; already the power of orderly co-operation under voluntary agreement has been developed; already such amounts of self-restraints have been acquired that most men carry on their lives without much impeding one another; already the altruistic interests felt by citizens in social affairs at large, are such as prompt efforts, individual and spontaneously combined, to achieve public ends; and already men's sympathies have become active enough to generate multitudinous philanthropic agencies—too multitudinous in fact. And if, in the course of these few thousand years, the discipline of social life has done so much, it is folly to suppose that it can not do more—folly to suppose that it will not in course of time do all that has to be done.

A further truth remains. It is impossible for artificial molding to do that which natural molding does. For the very essence of the process as spontaneously carried on, is that each faculty acquires fitness for its function by performing its function; and if its function is performed for it by a substituted agency, none of the required adjustment of nature takes place; but the nature becomes deformed to fit the artificial arrangements instead of the natural arrangements. More than this: it has to be depleted and dwarfed, for the support of the substituted agencies. Not only does there result the incapable nature, the distorted nature, and the nature which misses the gratifications of desired achievement; but that the superintending instrumentalities may be sustained, the sustentation of those who are superintended is diminished: their lives are undermined and their adaptation in another way impeded.

Again, then, let me emphasize the fundamental distinction. While war is the business of life, the entailed compulsory co-operation implies molding of the units by the aggregate to serve its purposes; but when there comes to predominate the voluntary co-operation characterizing industrialism, the molding has to be spontaneously achieved by self-adjustment to the life of voluntary co-operation. The adjustment can not possibly be otherwise produced.

And now we come round again at last to the general principle enunciated at first. All reasons for going counter to the primary law of social life prove invalid; and there is no safety but in conformity to that law.

If the political meddler could be induced to contemplate the essential meaning of his plan, he would be paralyzed by the sense of his own temerity. He proposes to suspend, in some way or degree, that process by which all life has been evolved—to divorce conduct from consequence. While the law of life at large is to be partially broken by him, he would more especially break that form of it which results from the associated state. Traversing by his interference that principle of justice common to all living things, he would traverse more especially the principle of human justice, which requires that each shall enjoy the benefits achieved within the needful limits of action: he would redistribute the benefits. Those results of accumulated experiences in each civilized society which, registered in laws, have, age after age, established men's rights with increasing clearness, he proposes here or there to ignore, and to trespass on the rights. And, whereas in the course of centuries, the ruling powers of societies, while maintaining men's rights against one another more effectually, have also themselves receded from aggressions on those rights, the legislative schemer would invert this course, and decrease that freedom of action which has been increasing. Thus his policy, setting at naught the first principle of life at large and the first principle of social life in particular, ignores also the generalized results of observations and experiments gathered during thousands of years. And all with what warrant? All for certain reasons of apparent policy, every one of which we have found to be untrustworthy.

But why needs there any detailed refutation? What can be a more extreme absurdity than that of proposing to improve social life by breaking the fundamental law of social life?

VIEWS OF RUNNING WATER.

By M. J. PICCARD.

IF we ask a person who has not thought about the matter to represent with a pencil, from memory, a stream or fall of water, in nine cases out of ten he will return the paper after having timidly ventured upon a few parallel scratches, looking as much as anything else like the ruts in a road or the hairs of a horse's tail. Yet we see liquids every day flowing along the gutter, and from bottles or pitchers; and we have all played near brooks and cascades. The persons who trace the parallel lines we have spoken of suppose they are representing the path traveled by the particles of water—that is, a movement, an immaterial thing which by its very nature defies all graphic representation. It is true that a luminous point in very rapid motion leaves on the retina the impression of a line. We are thus authorized to represent a flash of lightning, the course of a shell, and a gunshot; but we hesitate to resort to that artifice to represent the flight of an arrow through the air or the movement of a sword to strike. It will be well to make only a moderate use of it in representing water. In fact, these parallel lines do not exist, at least not under that form. Furthermore, lines do not show whether the stream is going to the right or to the left, or *vice versa*.

The effects accompanying the motion of water are, notwithstanding their extreme variety and apparent complication, subject to unchangeable hydraulic laws which it is possible to fix, with the aid of reason and experiment. Observation, even by itself, in the long run, develops an unconscious apperception in the inhabitant of the banks, whether he be fisherman, boatman, or raftsman. Special acquirements enable him to divine, according to the appearance of the surface, a thousand invisible things that are going on under the water. We do not, of course, intend to explore so vast a domain to the bottom, but to indicate how the subject may be approached, and how art and science are benefited by the investigation of it. What are the typical phenomena of running water, which, to simple sight, give rise to the impression of motion in a definite direction, and which are susceptible of being rendered graphically? Let us begin our experiments by fixing a low dam across an even-bottomed channel. Immediately above the dam the interrupted water will form a swell, on the back of which a system of fine parallel striæ may be observed. According to the depth and speed of the current, a second or several similar swells may be formed, but of lessening dimensions (Fig. 1). These are stationary swells, which we call eddy-waves or ripples.

To simplify the matter, we neglect what goes on below the dam. On the other hand, we inquire what happens when the dam is

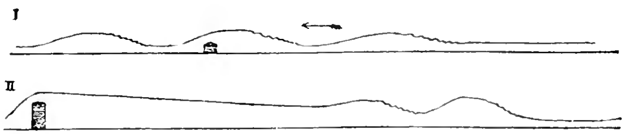

Fig. 1.

high enough to force the formation of a small lake. We should be apt to suppose that the water would pass, gradually diminishing in speed and increasing in depth, following a regular curve, from the condition of motion to that of relative repose. This is not the case. The passage is made suddenly, with a shock. The whole system of ripples and striæ which was before immediately at the head of the dam is transferred to the place where the water of the stream strikes against the comparatively still water of the lake. Besides, the two points being possibly distant from one another, the effect, or the eddy, appears before the cause, the obstacle (Fig. 1, ii). It is in this way, by the appearance of the surface, that the raftsman going down a river can judge, from the variations of speed, of the depth of the stream, and the size and position of reefs hidden under the water, frequently a considerable distance below the point where he is. Is not this the supreme end of art—to cause to be foretold by outer forms what is going on in the domain of invisible things, and to divine the reality without laying it bare? Water lends itself eminently to this end. It obeys mechanical laws, not as a machine which exposes them bluntly and fatally, but with a variety of suggestions and a lightness that leave the field clear for the imagination.

Let us, in our experimental canal, reduce the dam to a single obstacle in the middle of the stream. The eddy-wave, instead of being straight, bends around on either side, and takes the form of a parabola with a Λ more or less open according to the velocity of the stream. Moreover, the branches of the parabola, turned back by the side-walls of the canal, if it is not too broad, take a figure below the obstacle in which the first traces of a lozenge appear (Fig. 2, iii). Lastly, let us place the obstacles on the sides

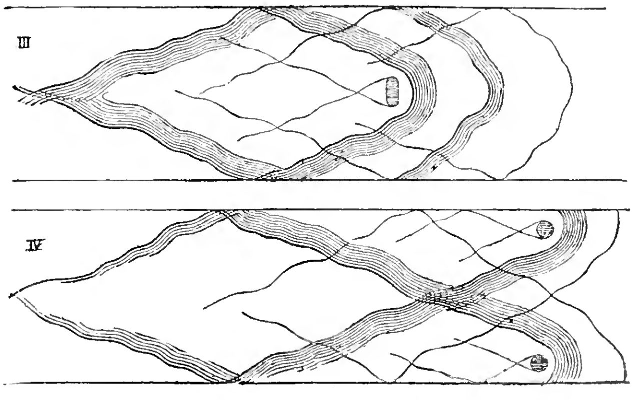

FIG. 2.—FORMS OF EDDY-WAVES.

of the canal. We find that the waves are turned toward the middle of the stream, and that by intercrossing with those coming from the opposite bank, and by their own return, a system of lozenges is produced on the surface of the water (Fig. 2, iv, and Figs. 3 and 4).

In this we see the pre-eminently typical phenomenon of running water. Every inequality of the shore, whether promontory or bay, plant or pebble, stake or bridge pier, is the starting-point for centripetal lines which go on in graceful undulations to lose themselves in the stream, or, meeting with others, to form quadrilles of rhombs, often with the most charming effect. By the direction of these lines the observer divines the course of the current, and their inclination furnishes him with an exact measure of its velocity.

In the case of cascades, the greater variety of the phenomena forces us to go more into detail. We begin with an inclined vessel, glass, pot, or pail, in process of emptying. How does the sur-

Fig. 3.—System of Lozenges produced by Eddy-waves.

Fig. 4.—System of Lozenges produced by Eddy-waves.

face of the outrunning liquid look? It would be safe to wager ten to one that any person at the first instance would represent it as in Fig. 5, v, by parallel parabolic lines. We not rarely find artistic productions in this style dating from the time when they composed landscapes from fancy in their studios. Without being too severe on these errors, which are still not far away from us, we will try to do better, and to correct the faults of the figure, one at a time.

We lay aside, for the moment, the usual ribbon-like form, which is false, and examine first the question of the vertical lines. They are formed by the series, *A*, *a*, *a*, of points by which the same molecule of water passes (or is supposed to pass) successively. Is there any proof of their material existence? No. It must be admitted that in certain cases, like that of a thin sheet falling from a regular dam or gliding over a smooth rock, the irregularities of the latter may produce lines in the direction of the current; but true painters make only the most moderate use of the straight line.

Are there not more grounds of resemblance between the points *A* and *B* or α and β which appertain, however, to different generators than between the points *A* and α of the same generator? Suppose the liquid sheet decomposed into its elementary veins; each of them is differently constituted in its several parts. At its

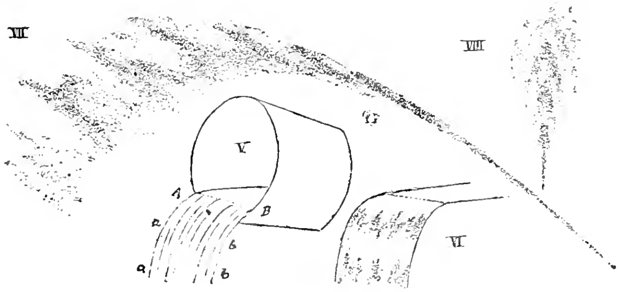

Fig. 5.

origin it is full, uniform, and transparent; lower down it shows real or apparent swellings and contractions; and still farther down it resolves itself into distinct drops. The water-sheet should consequently have an entirely different constitution at *A* from that at α, but the same at *A* and at *B*. It is proper, therefore, to represent as similar, not the points of the same parabola, but those of the same horizontal range; so, in the reflection of surrounding objects, the surface at the upper part of the parabola, making a smaller angle with the horizon, would produce a different effect from that at the lower part. At *A* and *B* it would reflect chiefly the sky; at *a* and *b*, perhaps, the rocks; while at α and β it would be white and reflect nothing.

Independently of phenomena which we are still to study, and paradoxical as it may appear, we can say that, if there are bands or zones in a cascade, they are rather horizontal than vertical. Our design vi, Fig. 5, still false and incomplete in many respects, looks more like a real fall of water than the design v, Fig. 5, with which we started. By this horizontal rather than vertical disposition of the effects of light, color, and reflections, the image gains much in life and truth.

When the eye has become accustomed, by repeated observations, to the peculiarities of the liquid elements, it can at last distinguish, in each jet of any velocity, a jerking or vibratory movement, a kind of trepidation or pulsation, directed horizontally, up and down, or down and up. It was believed formerly to be an optical illusion; but instantaneous photography and other observations establish beyond a doubt that the motion of a jet of water is never continuous, but is intermittent, periodic. Design vii, Fig. 5, which represents a jet from a hydrant or fire-engine at the moment of elevating, and design viii, representing a vertical jet from a narrow hole, are schematic but faithful reproductions of numerous observations. The photographs of Figs. 6 and 7, taken from nature at the overflow of a factory flume on Sunday, when no wheel or turbine was moving, are convincing.

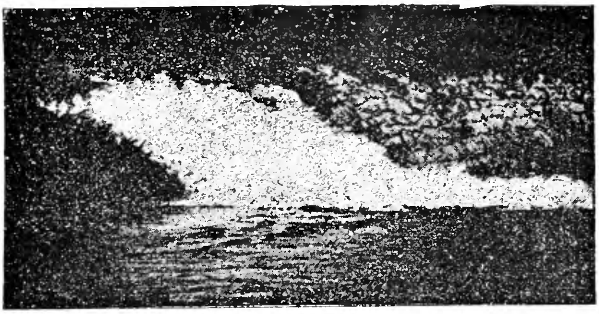

Fig. 6.—Vibratory Motion of Falling Water.

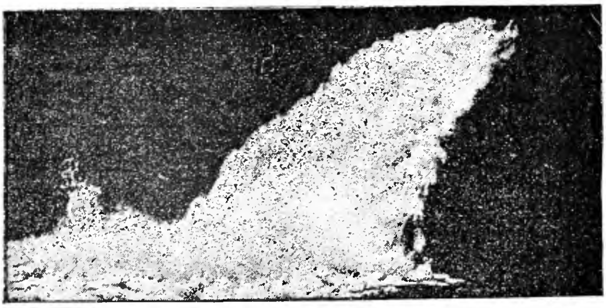

Fig. 7.—Vibratory Motion of Falling Water.

This intermittent character of the stream is due to the same cause as the sound produced by the air in blowing through a keyhole; it is produced in the same way as the wavy tufts in smoke escaping from a chimney. Water, as well as air, is elastic, but in a less degree, and differences in its pressure are propagated in waves. Ample explanations on the subject may be found in the chapters on undulations in treatises on physics; but the theory of the liquid wave is complicated, and far from being exhausted. We limit ourselves to saying that water, like air, is greatly disposed, every time the velocity of the stream is changed, by shock against a foreign body or by an abrupt contraction or enlargement of the channel, to go into vibrations and to communicate them to the walls of the orifice whence it escapes or to any object against which it strikes. Persons of delicate ear believe that they can distinguish the fundamental note of a cascade. Savart has determined the tone of a liquid vein. Another cause of discontinuity in a cascade is derived from waves in the river or the supply-basin, which, continuing into the fall, produce puffs and ripples. The phenomenon is accentuated by the resistance of the air. When, by any means, one of these jets deviates a little from the route which the one before it followed, the masses projected ahead, having to open the way, are retarded, and are then joined by those which follow them. The phenomenon is one of accumulation, like that which produces the billows on the sea-coast and the bars at the mouths of rivers, under the action of the tide. But shortly these bold spurts, rended and scattered by the same cause that produced them, the friction of the air, meet their end by being reduced to dust. When too near, the observer, engaged with a thousand details, is not struck so much as he is at a distance, by the phenomena as a whole and their periodicity. We can distinguish, then, the periodical ranges of jets which are partly transformed into spurts, and in the tumultuous rush between two rocks the bubbles or vibrations produced by the shock. The line is nowhere vertical.

When the waves coming down from the feeding-basin reach the upper edge of the cascade parallel to that edge, the bubbles are dispersed in horizontal bands. But if the wave comes down at an angle, it forms rows of inclined fringes; while, if the cascade is fed by a brook with the characteristic waves of Fig. 2 (iv), starting from both shores toward the middle, those waves will continue the same in the cascade in the shape of more or less stationary lozenges. In this case, again, we are far away from vertical parallel lines.

It is time to look more closely at the form and constitution of the liquid sheet. In Fig. 5 (v) it is represented by two parallel lines as a ribbon, such as any person not instructed would design from memory. It is in reality wholly different, as will appear from Fig. 8 (x). Let us begin at the top. Immediately at the opening of the flow, from the moment when it is wholly abandoned to itself, the sheet begins to narrow and take the form of a triangular tongue, pointed below. Let us, before we go further, look into the cause of this first change of form. When we make the experiment with an inclined cylindrical vessel, as in Fig. 5 (v), our inclination is at first to attribute the contraction to the oblique centripetal direction communicated to the lateral molecules by the elliptical form of the surface of the water in the interior of the vessel. This explanation is insufficient, for the sheet escaping from a tube, a canal, or a prismatic vase with parallel sides, assumes the same form Figs. 8 (x), 13, 14, 15, 16, and 17. The explanation that next suggests itself depends on the acceleration of velocity during the fall, which should have as a necessary result a progressive diminution of the section-surface. It may be proved experimentally that this has nothing to do with the triangular form by giving an upward direction to the jet from a flattened tube; the stream takes the form of a tongue all the same (Fig. 10).

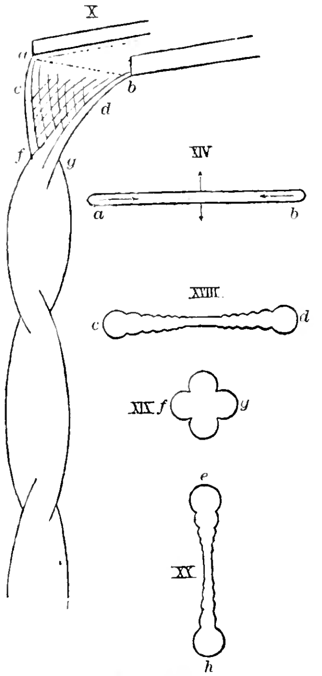

Fig. 8.—Form and Constitution of a Liquid Sheet falling.

Is it because the lateral parts of the liquid ribbon, having to overcome in the canal or the tube a more considerable friction than in the central part of the current, have at their issue a less mean velocity than the latter, and are therefore attracted by them? The effect incontestably exists; but we shall demonstrate, when we come to speak of the liquid vein, that it is negligible in comparison with another cause. After trying these various causes and eliminating them one after the other, we are brought to the conclusion that the essential cause that draws toward the middle the edges of a liquid sheet falling freely is the force of cohesion, or capillary tension. It is the same force that causes a freely suspended liquid mass to take the spherical form, as in Plateau's well-known experiment, and in the world of the stars. It is only in this state of least surface that the attractions between the molecules are in equilibrium. A falling liquid sheet will, therefore, tend toward a cylindrical or contracting form. Does it really become a cylinder and keep the form? What takes place lower down? These questions require knowledge of other peculiarities of the primary tongue.

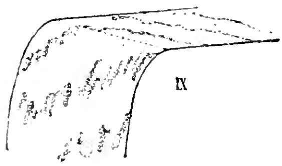

Fig. 9.

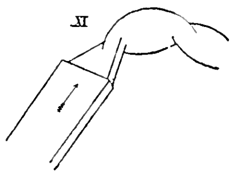

Fig. 10.—Tongue-like Form of a Jet of Water spurting from a Flattened Tube.

When water is subjected to a shock or to pressure, the pressure does not distribute itself insensibly through all the mass with gradual diminution. We have already shown this in the formation of swells by changes of slope in streams. We have another experiment. Slowly close a faucet till the liquid vein flows in a mere thread (Fig. 11, xv). The orifice in this case being perfectly cylindrical, the contraction is due on one side to the adherence of the liquid to the sides of the hole, and on the other side to acceleration, and takes place equally in all directions. Intercalate a solid body or a liquid surface at a few centimetres from the hole. The pressure at the base of the column augmenting by resistance, we might expect the vein to take the continuous form of two reversed cones (Fig. 11, xvi). It does not, but takes the form of swellings, of knots regularly placed, which give the vein the appearance of a chaplet (Fig. 11, xvii). This phenomenon, interesting as a case of action at a distance, and also as a case of vibrating action, has been observed by Savart and is described by him in the second of his memoirs. What the pressure caused by shock produces here, the pressure caused by cohesive attraction (capillary pressure or superficial tension) produces on the edges of the liquid sheet: a series of knots is formed. The section of the jet loses the form of the hole as soon as it leaves it, but the increase of thickness at the expense of breadth does not take place continuously; the central sheet is still thin and even, while the edges are already transformed into thick cords followed by other smaller ones. It is the same system of swells and ripples that we met before. The striæ of one side cross those of the other side, and the tongue is covered with a system of lozenges producing a very pretty effect (Fig. 8, x, and, in section, xviii).

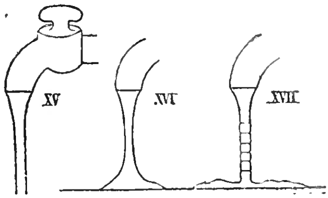

Fig. 11.

Now that we know the details of the form and constitution of the upper part of the liquid sheet, let us see what occurs lower down. On issuing from the canal, the lateral molecules of the sheet are subjected to the action of a component of horizontal centripetal velocity which turns them toward the middle. The particles in the middle, on the other hand, thrown toward the outside, acquire also a horizontal component, but centrifugal (Fig. 8, xiv). The point of stable equilibrium is where the jet has a cylindrical form. But there are various things to be observed.

As the rope-walker does not cease oscillating when he reaches the point of stable equilibrium, but by virtue of his inertia goes as far beyond it on the other side, so the horizontal oscillation of the molecules of water, repeating itself, produces a new sheet in a plane perpendicular to the first one, but this time in the form of a double tongue—that is, of a disk or lentil. The phenomenon repeating itself anew, a second contraction is followed by a new disk in the same plane as the first tongue, and so on; the disks alternating in the two vertical planes of breadth and depth, as in a paper *fidibus*. In the photographs reproduced in Figs. 16 and 17, a mirror fixed at an angle of 45° in the vertical plane gives, besides the front view of the vein, its image as seen in profile. A mechanical demonstration can be given of the movement of which the vein is the seat by a parallelogram of basket-work, which we press upon while holding it horizontally, and making it pass, by alternate compression of the extremities, from the oblong to the square shape, and then to the oblong the other way, return to the square, etc. The example of the *fidibus* is not quite exact. We comprehend at first that, in consequence of the acceleration, the disks will continue lengthening and deviating more and more—we can easily distinguish eight of them, sometimes twelve or more—till at last the molecules of water yielding to this dissociating action of weight group themselves in little cohesion-drops. There is another difference, in that the disks are not superposed as in the *fidibus*, but are boxed into one another—that is, one begins to form by deviation before the preceding one has done contracting. This is the necessary consequence of a third difference: that the disks are not plainly flat, but are thin in the middle, like the primitive tongue from which they are derived, and are flanked by thick cords on the edges (Fig. 8, xviii). We can, therefore, regard each disk as formed by the shock of the two cords of the disk above it. If this shock is exerted in a horizontal plane, the new disk will spread out equally in every direction, having its center at the point of the shock. Acceleration becoming a factor, the spreading is prolonged farther down than up; the disk is thrown out of center, but does not for that cease to encroach upon its predecessors. The case is like that of the links of a chain, which enter within one another. Nowhere, then, not even at the point of minimum surface, can the jet be cylindrical; at the minimum, it assumes the form of a rounded cross (Fig. 8, xix).

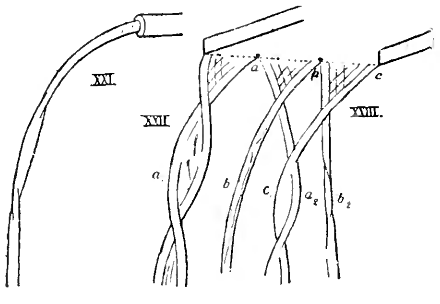

Fig. 12.

Thus we find that, in the phenomenon so simple in appearance of a fall of water, all the complications that arise one after another under the fullest examination are explained logically down to the most minute details. We can already draw one important conclusion: every mass of falling water, if it is not rigorously cylindrical and vertical in its origin, becomes necessarily the seat of horizontal oscillations—independently of the vertical vibrations which were first considered. Not a single molecule of which the

Fig. 13.

Fig. 14.

Fig. 15.

Instantaneous Photographs showing the Form of Liquid Sheets escaping from a Canal or from a Prismatic Vessel with Parallel Walls.

mass is composed follows a straight or parabolical line in its fall. All, without exception, describe a sinuous or zigzag course. Such is the general phenomenon. Let us follow out some of its details.

For the jet to be rigorously cylindrical in its origin is not a sufficient condition of its preserving that form. When it issues horizontally in full gush from a fountain, the parabolic trajectories, upper and lower, lose their parallelism and cause by approaching one another a flattening of the jet. From this fact arise horizontal undulations, only slightly marked, it is true, but which suffice, if the light is favorable, for producing the illusion of swellings and contractions (Fig. 12, xxi). Even when a liquid vein issues vertically from the bottom of a vessel by a circular hole, it assumes a helicoidal form in consequence of a motion of rotation which develops gradually within the vessel. This is independent

Fig. 16.

Fig. 17.

Escaping Liquid Veins and their Profiles, as shown by Reflection at 45° in the Vertical Plane.

of the vertical vibrations, of which the bottom of the vessel becomes the seat, and which it communicates to the whole jet.

The tongue-shaped sheet is bordered on its outer edge, as we have already shown, by swellings or cords, when everything is rigorously symmetrical; these two cords, meeting at the base of

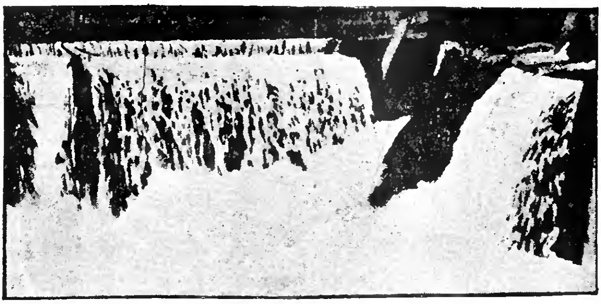

Fig. 18.—Instantaneous Photograph showing the Cords formed on the Edges of Liquid Tongues, as is seen in Fig. 14.

the tongue and flattening against one another, form a second sheet in a plane perpendicular to the former one—and so on. But when, for any reason, on account of the slight inclination of the canal, for example, it happens that the two cords do not exactly meet, one passes before the other, and one of two things may result. They will either roll up upon one another like a corkscrew and

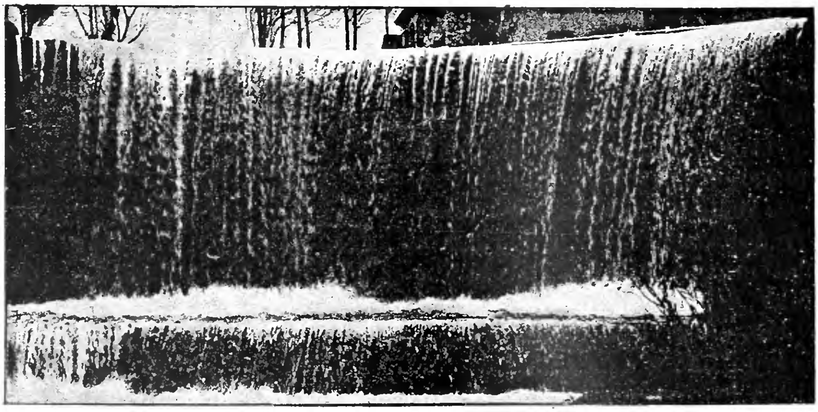

Fig. 19.—Photograph showing the Tremulousness peculiar to Cascades with Broad Sheets.

follow a helicoidal course (Fig. 12, xxii, and 13), or else, by some trifling cause they will miss, and, lanced in opposite directions, without regarding the thin median sheet that connects them, they will go each to its own side, never to find one another. The primary sheet is cut into two veins, which, losing trace of their common origin, remain definitely separated (Fig. 14).

When the sheet is very shallow and very wide, like that which spreads over a river dam, insignificant inequalities at the dam are enough to provoke a division into many distinct sheets. Consider two of these near one another (Fig. 12, xxiii). It may happen that cord a of the left arc and cord c of the right arc, coming very near to each other, join; thus are united molecules of water which an instant before had come out of the sluiceway at a considerable distance apart. Inversely, two molecules, neighbors till then arrived together at the same point b of the dam, are separated, one passing by b_1, the other by b_2, to reach the bottom widely separated. So also with the molecules a_1 and a_2. In the most regular fall, not a single molecule reaches the bottom by the most direct way. The same molecules which were traveling parallel in the bed of the canal, quietly keeping alongside of one another, seem, as soon as they reach the dam, to be suddenly taken with a frantic thirst for liberty, throwing themselves to the right and the left, joining, separating, and joining again; it is a go and come that never ceases till they find themselves newly imprisoned in the bed of a brook. Hence the serpentine course of the threads of water, the sparkling, the tremulousness which are common to cascades with broad sheets, and constitute their charm. The photographic reproductions (Figs. 18 and 19) represent, as well as can be done graphically, most of the characteristics which we have just described.

This is what occurs normally, under the influence of weight, cohesion, and inertia. When water runs out from a regular orifice, or over a horizontal dam, how complicated everything becomes when these conditions of regularity are not fulfilled, or when other forces come into play! One force that plays an important part in this matter is adherence between the molecules of the water and the walls of the vessel. This it is which often causes a liquid to follow a different way from that which is mechanically pointed out to it by inertia, weight, and cohesion. It then springs out into prohibited roads; instead of going to the cup held out to receive it, it chooses to follow the rim of a bottle and to spatter itself over the white cloth. Instead of precipitating itself into the pool with its companions, some capricious vein allows itself to be tempted by a nothing, to glide along a wall of rocks, and to trace those silvery threads which are often more graceful than the cascade itself. Yet adherence is a physical force, the effects of which may be foreseen and calculated up to a certain point. There are other factors, varying infinitely, but also calculable, which constitute, we might say, a part of the cascade, and contribute to impress a special, individual character on it—its height, the larger or smaller mass of water, the nature of the bed and the form of the opening through which the water escapes, the shape of the rocks over which it flows or against which it rebounds. Each stream of water has its own life. Pagans have personified rivers by surrounding their sources and their shores with divinities. To us, also, the torrent and its cascades are the soul of the valley.

And yet there is another and a foreign force that plays havoc with all our calculations—the wind. "Then, in the air, there are endless assaults between the coquettish sylph and the rogue who pursues her. Sometimes he seizes her of a sudden and carries her off with a puff to drop her as abruptly; sometimes he entices her and plays a thousand tricks upon her; then he grows bolder, embraces her, and makes her dance upon herself with a giddy velocity; and often he takes her so well on the wing that, like a flight of little floating clouds, she whitens in the distance in space. But soon the brook is formed again; it undulates and balances itself like a waving scarf, while all around a thousand limpid threads glide along the rock, and make a joyous court of falls in miniature to the green cascade."—*Translated for The Popular Science Monthly from the Revue Scientifique.*

CAN WE ALWAYS COUNT UPON THE SUN?

By GARRETT P. SERVISS.

THE study of the origin and development of species may be pursued with reference to the starry hosts, for there are different species of suns as well as of animals. The wide-ranging eye of the astronomer perceives in the dazzling orb whose rising turns night into day and whose beams vivify the face of the earth, only a minor representative of a great order of radiating bodies peopling the profundities of space. But, besides placing the sun in the comparatively humble rank to which he belongs by virtue of his inferiority in magnitude to many of his brilliant comrades, we are able to distinguish his particular breed, so to speak. He is not of the same kidney with such a sun as the dazzling Sirius, while the diamond radiance of Rigel and the sparkling blue beams of Vega proclaim that those stars are in some important respects different and more splendid organisms than our sun.

While there can be no question that suns have a life-history, a beginning and an end marking the termini of a regular process of development, and that consequently the stars that we see differ in age, still it is not yet possible to say with absolute certainty at just what point in the scale of solar development our sun, or any other particular star, has arrived. According to some views, the sun is an older star than Sirius; according to others, it is younger. The question whether a sun is still approaching the climax of its radiative energy, or has passed that point and is descending the scale, is an important one as regards the ultimate destiny of inhabited worlds revolving around it. It is upon the revelations of the spectroscope, assisted by photography, that we must depend for the advance of our knowledge of the condition of the various orders of suns. Upon spectroscopic evidence the stars are ranged into four principal classes distinguished by the kind and extent of the absorption which their light undergoes in passing outward from their photospheres through their gaseous envelopes or atmospheres. Sirius stands as the most brilliant representative of the first class, sometimes called the white stars, in whose spectra the lines of hydrogen are very conspicuous while other lines are few and faint. Some of the stars of this class have a splendid blue tint in their light. More than half of all the stars whose spectra have been studied belong to the first class. Vogel thinks they are the youngest stars, and that their youthful fires represent the most intense development of solar heat. If they are the youngest, then, on account of their great number as compared with the other stellar classes, it is evident that the universe has not yet passed the high noon of life; in other words, that the starry system, taken as a whole, is still in its prime, if indeed it has as yet attained the summit of its development as a community of suns. But the correctness of Vogel's assumption that the stars of the first class are all younger than those of the other classes is seriously questioned, and, as Prof. Young says, "it is very far from certain that a red star is not just as likely to be younger than a white one as to be older."

The second class is represented by Capella and our own sun. These stars are evidently surrounded by a far more complicated envelope than is the case with the white stars. Metallic vapors suspended above their photospheres in great variety serve to absorb a large part of their radiation, so that the spectrum of their light as it comes to us presents an enormous number of black lines, showing that it has been sifted through the vapors of iron, calcium, platinum, and many other metals, each of which, existing at a lower temperature than the fiercely glowing surface beneath, has arrested from among the passing rays those peculiar to itself. Some of the hydrogen lines also exist in the spectra of stars of the second class, but they are no longer conspicuous above the others. The second-class stars often called the solar and sometimes the yellow stars, are far less numerous than the white stars, the proportion, so far as known, being about one to six.

In the third class we come to the red stars, the majority of the stars of that color, as well as most of the variable stars, falling within this category. In these stars the absorption of their vaporous envelopes is so pronounced that their spectra are darkened by bands as well as lines. Sometimes *bright* lines of hydrogen appear in the spectra of stars of this class, indicating that an envelope of that element surrounding them has blazed out with an intensity of heat exceeding that of the photosphere itself. Betelgeuse, the great orange-colored star in the shoulder of Orion, is a representative of the third class. The wonderful variable Mira, in Cetus, also belongs in the third class of stars.

The fourth class is small in number, and its members are inconspicuous in brightness and shine with a deep red light. Their spectra are also filled with bands of absorption which are peculiar in that they shade off gradually toward the blue end of the spectrum, while the bands in the third-class spectra shade off toward the red end. This peculiar spectrum appears to arise from a compound of carbon filling the atmosphere of the star. Variable stars also abound in the fourth class and bright lines are sometimes seen in their spectra. Even if we grant that the progress of stellar evolution is from the white through the yellow to the red stars, and so on to complete extinction, it does not appear possible to say with certainty that the stars of the fourth class are any closer to final extinguishment than those of the third. It would be a very beautiful thing if one variety of red stars could be recognized as representing a class younger than Sirius, while all other red stars were known to be older than the sun, but that can not be affirmed. So far as our present knowledge guides us, the most that we can assert is that red stars may be either the youngest or the oldest of suns, or some may be young and some old; but that, at any rate, they probably stand near one or the other end of the progression, since they are clearly inferior in efficiency of radiation to the other stellar varieties.

Now, as regards the existence of planets circling around the various classes of suns, we can only reason from analogy; and opinions upon the subject range all the way from Dr. Whewell's conclusion that the earth is probably the only inhabited world in the universe, to Dr. Chalmers's delightful picture of the starry heavens filled everywhere with intelligent beings worshiping their Creator. Suppose we examine the probable conditions prevailing around the stars of each of the four great classes. The white stars, like Sirius, possess an extraordinary potency of radiation. Their atmospheres are not strongly absorbent, and probably not extensive, and consequently nearly the full vigor of their beams is poured upon the satellites that surround them, if any such there be. According to recent estimates, Sirius, while shining with perhaps seventy times the light of our sun, is only between two and three times as massive, so that the intensity of its radiation is enormously greater than the sun's. Planets situated as close to Sirius as the earth and the other inner planets of our system are to the sun, would be unable to endure, so far as their life-bearing functions are concerned, the gush of heat and blaze of light poured upon them—unless, indeed, the organization of living beings there were entirely different from that prevailing here. We should then expect such stars as Sirius, if they are the centers of planetary systems at all, to be surrounded by globes revolving at comparatively great distances and in long periods of time.

Coming to the second class, or solar stars, we find that the more extensive atmospheres which surround them, and absorb no inconsiderable portion of their rays, serve as a sort of protective curtain for their planets. There can hardly be a doubt that if the envelope of metallic vapors that incloses the photosphere of the sun were suddenly removed, life, at least in many of its more complex forms, would be banished from the earth, and perhaps be rendered impossible upon any planet nearer than Jupiter.

But it is the red stars and variable stars of the third and fourth classes that present the most unfavorable features from the planetary point of view. Probably no star belonging to these varieties is free from extensive and more or less spasmodic alterations in the amount and intensity of its radiation. Take such a star as Mira, for instance, alternately dying down almost to extinction and then blazing out with more than a thousand times its former brilliancy, these tremendous changes occupying, for a complete cycle, only eleven months! Is it possible to suppose that inhabited planets exist within the domain of an orb like that? When a sun is half smothered in absorbing vapors, and subjected to paroxysms such as those which are occasionally beheld when the atmosphere of a star appears to catch fire, as it were, and the lines of hydrogen and other elements flame bright like signals of conflagration, it can no longer be the center of a system of life-bearing worlds, no matter what its past history may have been in that respect.

It is apparent, from what we have just said, that progress by our sun in either direction—toward the white stars or toward the red stars—would, in the end, prove exceedingly uncomfortable if not fatal to the inhabitants of the earth. By the subsidence of the vapors of metals that now stripe the solar spectrum with their absorption we should be, in effect, removed into the presence of a Sirius whose fierce beams would smite the living world with death. On the other hand, let the sun sink into the condition of a red star, and become variable in its outpourings, and our condition would be even worse. If it be thought that a planet whose orbit is as eccentric as that of Mercury is hardly habitable because it receives twice as much solar heat at perihelion as at aphelion, what is to be said of the condition of a planet subjected to the terrific mutations of Eta Argus, a star that in 1843 rivaled Sirius itself in brilliancy, and that since 1868 has been invisible to the naked eye, and has sunk as low as the eighth magnitude? Some of the comets undergo far less severe alternations than such a world must endure. In either direction, then, the prospect of solar evolution seems unfavorable, considered from the planetary standpoint. What the planet most wants is an unchanging and unchangeable sun. But this is impossible. In the presence of eternity a sun, whether it grows hot or grows cold, white or red, with age, is a thing as essentially evanescent as a zephyr.

But we can not rest with the assumption that, since the sun is evidently no Mira and no Sirius, therefore it is practically an unchanging radiator which for an indefinite period will continue to cause the earth to bloom in the beneficent effulgence of its life-inspiring rays. A sun may affect the welfare of its planets either through the gradual mutations which it undergoes in the course of its evolution, or through the more rapid and violent changes that characterize the stars that are ranked as variable. We have seen that most of these latter belong to the third and fourth classes, but there is reason to suspect that the majority of all the stars are variable to a slight degree, and evidence of variability in the case of the sun is furnished by the phenomena of sun-spots. A spectator, viewing the sun from a distant point in space, would perceive that its brilliancy was slightly increased once in about every eleven years. These accessions of light should correspond, not with the periods of fewest spots, but with those of most spots, because the energy of the sun's radiation is greatest during the spot maxima. At present a sun-spot maximum is approaching, and since last winter the face of the sun has frequently exhibited startling indications of the tremendous disturbances now affecting the solar globe. Our imaginary observer in space would probably behold at the present time a very slight increase in the sun's brilliancy, and this increase may go on for three or four years to come. While we, dwelling upon a globe that is bathed in the sun's rays, may be unable to perceive these variations directly, yet their effects have long been recognized by the changes that they produce in terrestrial magnetism. It is also highly probable that a perceptible influence upon the weather is exercised by variations in solar radiation corresponding with the presence or absence of sun-spots. So far as trustworthy observations have gone, it appears that the temperature upon the earth is slightly lower when sun-spots are most numerous. This is exactly the opposite to the effect that might have been anticipated; but as the observations from which the inference is derived are confined to India, it seems probable that the lowering of temperature, while primarily brought about by the condition of the sun, is directly due to the action of local causes, and that in other parts of the earth a simultaneous increase of heat may be experienced. A very great increase of solar radiation, however, could not be thus masked in its effects upon the earth.

Although during the historical period there has probably been no sufficient variation in the activity of the sun to produce very serious terrestrial results, yet it is known that the sun-spot cycle is subject to considerable variations, both as regards the length of the periods and the intensity of the forces concerned in the disturbance. The latest maximum of sun-spots in 1883–'84 was a couple of years overdue. What peculiarities may mark the maximum now approaching time alone can reveal. But, at any rate, the known irregularities of the sun suggest a striking resemblance to what we see in some of the variable stars; and it is highly probable that the changes of the latter, except in certain cases where other more satisfactory causes have been inferred, are due to phenomena resembling sun-spots, if not in fact directly analogous to them. Is sun-spottedness, then, a progressive condition; and will our sun in time become, through this cause, variable to the extent shown by many of its compeers in the heavens?

It is true that on account of the remoteness of any calamitous effects resulting from such gradual changes in the sun's condition we can afford to regard them with indifference, so far as the welfare of our race for many thousands of years is concerned; but when we rise to a higher point of view, and put aside merely human measures of time, the question becomes one of deep interest, since it involves the probable ultimate fate of our planet as the scene of the development and achievements of intelligent creatures. Will the earth become a desert like its companion the moon through the exhaustion of its vital forces and the disappearance of its air and water, while the sun yet shines upon it with unfailing splendor; or will the end of terrestrial life be brought about by the agency of the sun itself, either through the failure of the solar energies, or through an overwhelming outburst of them? These questions are not the less interesting, and not the less certain to obtrude themselves, because it is at present impossible for us to answer them. They have also a bearing upon the geological life record of the globe. Already, under the enormous demands for time made by the evolutionary doctrine, geology is asking for far longer periods of stability in the light and heat supplies of the sun than astronomy, also supporting itself upon the principles of evolution, is able to grant. But if the sun has emerged from the stage of a third or fourth type star, and by the gradual elimination of its obstructive envelope has arrived at that point of comparative regularity of radiation in which we behold it, the time during which it can have maintained the earth in a habitable condition is proportionally shortened, for we can not suppose that animal and vegetable life could be developed under the dominion of a distinctively variable star. The assumption is here made, of course, that a variable star is really a sun and not a cloud of meteorites in collision, or a partially condensed nebula, and that its planets, if it is ever to have any, have already been formed. Progress in the other direction—that is, from the white star toward the red star and variable star stage—would seem to supply longer periods of unvarying solar radiation for the evolution of planetary life, since a sun developing in that way would become a stable radiator sooner than if it had first to free itself from a sheathing of absorbing vapors created, it may be, by its own action at a certain stage of its career rather than left behind as a subsiding remnant of the original nebula.

We have remarked that, so far as the records of human history inform us, the emission of light and heat by the sun has never seriously varied. Yet it has been thought, though the evidence is not clear, that there are geological indications of considerable variations in the amount of solar radiation in past time, and the famous myth of Phaeton driving the chariot of the sun and getting so far out of his road that he endangered the earth and made it smoke with unwonted heat, has often been referred to as a possible tradition of some extraordinary outburst of solar heat within the period of man's existence. The variable character of sun-spot phenomena certainly does not contradict that supposition. The margin of existence is so narrow for many forms of life that no very great change would be required to cause a disaster. Still, notwithstanding the vagaries of sun-spots, and the apparent analogy between the sun and the variable stars, it would not do to assume that the earth is at present in any danger from a changing mood in its great governor and benefactor. So far as positive records serve as an indication of the future, there is every reason to believe that the sun will long continue in its present condition, and that astronomers a million years hence, if some cataclysm arising from ulterior causes does not intervene, may still be found studying the sun, having probably by that time ascertained whether it is getting hotter or colder. But it would not be safe to assume that any astronomers will be left upon the earth five million years hence.

The inquiries of the British Labor Commission have brought out the fact that some of the workmen believe that the state should by penal enactment prevent all men over sixty years old from working for wages, giving them instead of work a pension. Their theory is that to give work for pay is a benefaction to the community, for which gratitude and a reward are due them.

A CLASSIFICATION OF MOUNTAIN RANGES ACCORDING TO THEIR STRUCTURE, ORIGIN, AND AGE.*

By WARREN UPHAM,
OF THE UNITED STATES GEOLOGICAL SURVEY.

THE sea, in its vastness, reaching far beyond the encircling flat horizon, is a better symbol of infinitude and of eternity than is the most majestic mountain range, lifting its serrated forehead miles above the ocean-level and seeming almost to pierce the sky. The sea itself, but no part of the land forming its shores, has continued unchanged through the series of geologic eras.

"Time writes no wrinkle on thine azure brow—
Such as creation's dawn beheld, thou rollest now."

But on the land, no sooner have the subterranean forces upheaved a mountain, a plateau, a continent, or an island, than the processes of subaërial erosion begin to contend against it. Rains, frost and heat, chemical change, subdue the most enduring and solid rock formations, dividing them with fractures, and pulverizing their masses and fragments to sand and clay, which gravitation by the vehicle of running water carries down and away to the sea, there to find rest until another uplift shall renew the cycle of changes. "The mountain falling cometh to naught, and the rock is removed out of his place."

The form of mountains and of their ranges and systems is due to the combination, in varying ratios, of constructive and destructive agencies. The first only seem necessary; but the second have generally been far more efficient to give the shape and outlines of all our mountains, excepting volcanoes. Constructive forces have done work that may be compared to the quarrying of the block of marble and bringing it to the artist's studio; destructive forces, producing the present mountain forms, as they stand before our vision, have done work like chipping away the greater part of the marble block and chiseling it to the finished statue. It will be convenient to speak of the constructive processes as mountain-building, and of the destructive as mountain-sculpture.

It is from observation and study of the geologic structure of mountain ranges, the diverse rock formations of which they are composed, and their attitude and relationship to each other, that we discover and understand their origin; how, by what agencies, the mountains have been built and sculptured. Structure and origin are thus very intimately connected and demand the same division under classes and types. In this classification, when citing examples of each type, we can commonly note also their geo-

* Read before the Appalachian Mountain Club, April 8, 1891.

logic age, or the epochs of deposition of the rocks forming the mountain range, the epoch of their upheaval or successive upheavals, and the subsequent time during which they have been exposed to erosion.

Six classes of mountain ranges may be discriminated which, from predominant features of their structure, may be named as (1) folded, (2) arched, (3) domed, (4) tilted, (5) erupted, and (6) eroded. In each class the present contour of peaks, ridges, buttresses, and slopes has commonly been produced by the destroying frost, storms, and streams; but wherever some special phase of mountain-building is discoverable within the disguise which the superficial transformation has imposed, the mountain range or separate mountain is thereby referred to its constructive type. The last-named class, therefore, is intended to include only those mountains and ranges which owe their prominence to the denudation of an equal or greater thickness of the same rock formations from the surrounding country or from the valleys that divide them from other mountains, while the structure of the masses spared by this erosion does not place them in either of the five preceding classes as areas that have experienced mountain-building or orogenic movements. The sixth class belongs to areas where continent-building or epirogenic movements of widely extended elevation have been followed by so deep erosion that mountains have been made wholly by sculpture. Often the processes of mountain-building have combined in the same range the features which give names to two or more of these classes, but usually there is some chief element in such complex structure, predominantly allying the range with one of the five orogenic types. Faults, as the geologist calls dislocations of the rock formations, where the portion of the earth's crust on one side of a plane of shearing has been borne upward or forward, while the portion on the other side has fallen downward or backward, often complicate each of the six classes of mountain structure; and they are the sole or principal means of formation of the fourth, that is, of tilted ranges.

The plan of this essay is to examine the structure of each class, and to inquire what was the manner of action of the mountain-building or orogenic forces producing each of the five constructive types, and of the continent-building or epirogenic forces producing the broad, elevated expanses from which erosion has formed the sixth type, mountain remnants of destroyed high lands. Examples of each class are described, and the geologic age of their rock formations, of their upheaval, and of the ensuing erosion, is stated so far as it has been studied out, giving thus, in a brief way, both a description and a history of the mountain range or system.

1. Folded Mountain Ranges.—Foremost in their geographic importance, and in the intricacy and significance of their geologic structure and origin, are the mountain belts which consist of folded rock formations. The strata forming the upper part of the earth's crust are bent up and down in long, nearly straight or curving, wave-like ridges and troughs, and where their disturbance was greatest the successive ridged folds are closely pressed together. The waves of the rock structure are then pushed to such steepness that their sides become parallel with each other, and the entire fold is driven forward into an inclined position. The order of the strata on the lower side of the appressed fold is thus inverted; the originally highest and last formed deposits there lie beneath older beds, in an overturned series. Subaërial erosion then wears down the undulations and the crests of the closely folded strata, often planing them off until a long section, crossing mountain ranges, passes from older to newer beds, and onward from newer to older, in several alternations, having throughout the whole a nearly constant steep dip. Owing to the interbedding of hard and enduring sandstone, quartzite, gneiss, and other rock formations, with more easily eroded limestone, shales, incoherent sandstones, or schists, the erosion commonly produces a new topography, making hollows and long valleys where the more erosible beds have been removed, and leaving ridges and mountain ranges of the harder rocks. More than this, when erosion has been continued through very long periods, it tends toward the ultimate result of removing the upward curved or anticlinal portions of the great folds and sparing the originally lower downward curved or synclinal portions, until valleys take the places which were originally occupied by the highest upheavals, while the original troughs, where the rocks were most compacted by pressure, remain now as the principal mountain ridges. Under denudation, the folded mountainous belt fulfills the prophecy, "Every valley shall be exalted, and every mountain and hill shall be made low."

The most perfect type which the world affords of this structure, or at least the example which has been most fully studied as to the age of its strata, the dates of their foldings and upheavals, and the effects of erosion, is the Appalachian mountain system. As made known by the brothers W. B. and H. D. Rogers and by later geologists, a vast series of Palæozoic strata, representing continuous deposition from the early Cambrian to the close of the Carboniferous period, is thrown into many long, steep folds in the Appalachian ranges of Pennsylvania and the Virginias, making the southeast part of this mountain system, and into plateaus and gentle undulations in the Catskill, Alleghany, and Cumberland Mountains, which are its northern and western portions. After the formation of the coal measures, the thick sediments that had been laid down in the subsiding eastern margin of the Palæozoic ocean, which extended westward over the present basins of the Laurentian lakes and the Mississippi, were compressed into folds and raised to constitute a mountain mass one thousand miles long and seventy-five to one hundred miles wide, with probably much greater altitude than now. During Permian and Triassic time, according to Prof. W. M. Davis, this elevated area was channeled by rivers and finally was mostly worn down to a broad base-level or a moderately undulating expanse. Renewal of elevation, occurring in the Jurassic period, was probably attended with the remarkable overthrust faults, having apparently a maximum extent of about eleven miles of horizontal displacement, which have recently been studied out by C. W. Hayes, similar to the thrust-planes discovered by Peach and Horne in northwestern Scotland. Another cycle of base-level erosion is shown by Davis to have extended from the Jurassic upheaval to the end of the Cretaceous period, reducing the Appalachian Mountains to a lowland tract, in part nearly flat and in part hilly, which he names the Schooley peneplain. This tract, almost a plain at the close of the Mesozoic era, was then a third time upheaved; and the present valleys of the Appalachian belt, divided by very long mountain ridges of uniform height, have been cut by river erosion during the Tertiary and Quaternary eras.

Closely associated with the foregoing are other folded groups and ranges of mountains, which Prof. C. H. Hitchcock has named the Atlantic mountain system, first raised as mountain masses in the Cambrian and Silurian periods, long before the great Appalachian revolution terminating the Coal period. In order from northeast to southwest, this system comprises low mountains in Newfoundland and in the eastern provinces of Canada, south of the St. Lawrence; the mountains of Maine; the White Mountains; the Green Mountains; the Hoosac and Taconic ranges; the Hudson highlands; Schooley's Mountain and other ranges in New Jersey; the South Mountain in Pennsylvania; the Blue Ridge in Virginia; and the Blue Ridge, the Stone Mountains, and the Iron, Bald, Smoky, and Unaka ranges in North Carolina. This mountainous belt, extending nearly two thousand miles, is everywhere characterized by overturned folds, and by intense metamorphism, the sedimentary strata, originally shales, sandstones, and conglomerates, being changed to crystalline schists, gneiss, and granite. Denudation of the Atlantic mountain system, and of lands stretching eastward over part of the present Atlantic Ocean area, supplied the deposits which were upheaved in the building of the Appalachian ranges.

A still older Laurentian mountain system, first upfolded in the Archæan era, is to-day represented by the Adirondacks, the Laurentide highlands, and the mountains of Labrador, Baffin Land, and Greenland. Asking, then, how the mountain-building forces of eastern North America have been manifested, we see that the upper part of the earth's crust here has been folded by pressure from the Atlantic toward the central area of the continent, exerted during certain epochs of mountain formation, which have alternated with long intervals of repose and of base-leveling by stream erosion. Three chief epochs of orogenic upheaval have produced the intimately blended Laurentian, Atlantic, and Appalachian mountain systems, which geologists distinguish because of their diversity in age and in many of their physical features, but which geographers unite as the eastern mountainous belt of our continent. As a whole, it may perhaps properly be called the Appalachian, or, better, the Appalachian-Laurentide belt.

Other examples of this structure are developed on the grandest scale in the Old World, comprising the Atlas Mountains, the Pyrenees, the Alps, the Apennines, the Carpathians, the Balkans, the Caucasus, the Elburz, the Hindoo Koosh, and the Himalayas, together reaching from the Pillars of Hercules to the China Sea. These complex mountain systems may collectively be called the Alp-Himalayan belt. During the Miocene, Pliocene, and Glacial periods to the present time, compression has been exerted on each side, upbuilding its mountain chains, which cover a length of about eight thousand miles, occupying a third part of a great circle. In North America the Laurentian mountain system belongs to the remote beginning of the geologic record, and the Atlantic and Appalachian systems are very old, having repeatedly been almost base-leveled; but these principal mountains of northern Africa and of Europe and Asia are geologically very new, the highest being still in the growth of infancy and youth. When upward growth ceases, erosion triumphs and by slow degrees sweeps the mountain mass into the sea. The perpetuation of ancient mountain systems has depended on repeated upheavals, and in their present condition they are remnants spared from the erosion of areas lately elevated. Portions of this great Eurasian mountain belt began to be plicated and thrust up long before the Tertiary era, and doubtless some of its mountain systems were comparatively undisturbed during the Tertiary and Quaternary folding and upbuilding of the Alps and Himalayas; but mainly the prominence of the belt is due to the lateness of the plication, and in part to its being now in progress.

Nearly all the principal mountain systems of the world have a folded structure, but in many instances they retain no semblance of their primal undulations and earliest contour. In the mountainous plateau of Scandinavia and its outlier, the Scottish

Highlands, only the bases of the ancient mountains remain. Eroded, perhaps repeatedly, almost to the sea-level, these plicated areas have been again elevated and are now deeply incised with valleys, fiords, and lochs. In the western mountain belt of North and South America a long and eventful history of extended plication and upheavals in many separated geologic epochs is more or less clearly revealed; but the latest accidents befalling this belt during the Quaternary era will call for special description under the fourth structural type, with which the earlier revolutions of this most prolonged mountain chain will be reviewed.

2. Arched Mountain Ranges.—Far less frequent than the foregoing, and indeed known only in parts of the Cordilleran belt of the western United States, is the arched structure, which may be best described in its most typical example, the Uinta range of northeastern Utah. According to Powell's report on the geology of these mountains, a great thickness of many rock formations has been here raised in an arch about one hundred and fifty miles long from east to west and thirty to forty miles wide. The strata range in age from the Archæan and Cambrian to the Cretaceous and Tertiary, and they appear to have reposed horizontally, as laid down in the sea, until the end of the Cretaceous period. The upheaval took place during the Tertiary era, mostly in its earlier portion, and the whole extent of the upward arching was about five and a half miles. Erosion, however, has gone forward during the growth of the arch, so that the highest peaks of the range have an altitude of only about two and a half miles, or thirteen thousand feet. Upon each side of the Uinta arch and about its ends the stratification is steeply inclined and occasionally cut by faults; but higher up the inclination diminishes and the strata extend across the top as a flattened dome, without folding or dislocation.

How were the mountain-building forces applied to form this arch? Its short extent in proportion to its width and the absence of plication make it difficult or impossible to refer it to lateral pressure, which has been regarded as the manner of application of the energy forming the great folded ranges. All the features of the Uinta range, instead, point to upward pressure as the form of mountain-building energy to which its elevation was due. It is very important, however, to note that the process of the Uinta elevation was so gradual and slow that the rivers which flowed across the area before its upheaval were not turned aside, being able to cut down their channels, which in the heart of the mountains are precipitous, narrow cañons, as fast as the elevation progressed. After the consideration of the remaining types of mountain structure, we shall further examine this question of the method and the origin of the diverse manifestations of mountain-building.

Adjacent to the east end of the Uinta arch, two similar but small upthrust mountains were formed at the same time, and repeat the same structural type in its essential features, but they have sharply arched crests, and their longer axes run from north to south, at right angles with the major axis of the Uinta range. These are Junction Mountain, about twelve miles long and four miles wide, and Yampa Mountain, seven miles long and about three miles wide. Both are cut by the Yampa River, flowing directly through them in deep cañons, instead of passing around, thus showing that these very short upthrusts, like that of the larger range, were gradual, not sudden, in their development. The vertical extent of the upward arching of the strata to form each of these mountains, counteracted meanwhile in large part by denudation, is believed to have been somewhat more than two miles; and this great elevation of so small areas was yet not too rapid to permit the river to keep pace with it in the downward cutting of its cañons.

3. Domed Mountains.—The structural type here designated is exemplified by the Henry Mountains in southern Utah, which have been elaborately studied by Gilbert. These mountains were formed as dome-shaped or bubble-like but gigantic uplifts of previously horizontal Carboniferous, Jura-Trias, Cretaceous, and Tertiary formations, by the volcanic injection of immense lenticular masses of porphyritic trachyte between the strata of the series. The injected lava mass is named by Gilbert a laccolite (cistern-stone). Whereas in the first type of mountain structure the formerly horizontal strata were thrown into folds, and in the second were curved upward in great arches, they here were simply lifted quaquaversally, as a geologist would say, in vast domes. Mount Ellsworth, the most southern of the Henry Mountains, was lifted by only one laccolite; Mount Holmes, the next northward, by two; Mounts Hillers and Pennell, next in order to the north, each by one large and several smaller laccolite intrusions; and Mount Ellen, the most northern mountain of this group or range, was puffed up by many, perhaps thirty, of these cistern-like masses of lava. The Henry Mountains extend about thirty-five miles from south-southeast to north-northwest, with a width of five to ten miles; and their highest summits rise about five thousand feet above the plateau of their base, or eleven thousand feet above the sea.

From these summits the view embraces within distances of fifty to one hundred and twenty miles northward, eastward, and southward, no less than five other mountain groups of this type, namely, the Sierra La Sal, the Abajo, La Lata, Carriso, and Navajo Mountains; and two hundred miles to the east the Elk Mountains of Colorado belong to the same class. The Henry Mountains and these other groups were all probably uplifted near the middle of the Eocene period, the first of the three divisions of the Tertiary era. They were contemporaneous with the growth of the Uinta range and the Junction and Yampa Mountains; but the Henry structure represents sudden lifting by the energy of volcanic inflows of molten rock, while the Uinta structure, as we have seen, represents a very gradual upheaval. The two can not be referred to the same means of elevation, though their more remote causes were doubtless nearly related or identical. No laccolite mountains are known in other countries, and here they are found only in the region of plateaus which is intersected by the cañon of the Colorado.

4. Tilted Mountain Ranges.—Next to the west of the Colorado drainage area is the Great Basin of interior drainage, which returns all its rainfall again to the clouds by evaporation. Were the lakes of this arid region to grow by increased rainfall until they should flow across the lowest points of their water-sheds and send streams to the ocean, two of them would be similar in area to the Great Lakes of the St. Lawrence. Twice during the climatic changes of the Glacial and Post-glacial epochs, these two lakes, named Bonneville and Lahontan, have so risen nearly or quite to overflowing, whereas now the former is represented by Great Salt Lake in Utah, and the latter by Pyramid and Winnemucca Lakes, with others in Nevada. Close east of Lake Bonneville rises the Wahsatch range, and west and southwest of Lake Lahontan is the Sierra Nevada, both of which are examples of tilted mountain ranges. The Wahsatch has been elevated along fault lines which form its western boundary, adjacent to the area of Lake Bonneville and the present Great Salt Lake. It is an immense mountain mass which has been tilted by upheaval of its western border and sinking of its eastern portion. The Sierra Nevada, on the other hand, has been upheaved along fault lines bounding it on the east, and is concisely described as principally a single great block of the earth's crust, about three hundred miles long from north-northwest to south-southeast, and fifty to seventy miles wide, tilted by elevation of its east side and depression of its west side. Between these grand mountain ranges which look toward each other on the east and west limits of the Great Basin, many minor ranges occur, trending from north to south, all of which have the same structure and origin through faulting and tilting, so that this is called by Powell the Basin type of mountain structure.

The great disturbances producing the Basin ranges were of late geologic date, in the early part of the Quaternary era. The resulting mountain ranges are still very young, geologically speaking, and therefore some of them rank among the most prominent on this continent. During more remote periods doubtless many ranges in various parts of the world have been formed in this way, their sites being now marked by profound faults which are clearly traceable, though the tilted mountains of the upheaved side of the faults have long since passed through youth, maturity, and old age, leaving no topographic evidence of their former existence.

Many stages of mountain-building have left their impress on the great Cordilleran belt of the western part of the United States and the Dominion of Canada. The Gold and Selkirk ranges of British Columbia, according to Dr. George M. Dawson, consist of Archæan, Cambrian, and Silurian formations, which were pushed up into mountain folds before the close of these very ancient divisions of geologic time. The auriferous slates of the Sierra Nevada, as Becker has shown, were similarly built up in a folded mountain range at the close of the Gault epoch in the Cretaceous period. During the ensuing long lapse of time to the end of the Tertiary era, this precursor of the Sierra Nevada range had been worn down to only a moderate elevation by the gnawing frosts, heat, rains, and running streams; but the beginning of the Quaternary era, according to Le Conte and Diller, brought revolutionary changes. The previously base-leveled region which now forms the Great Basin was then upheaved as a high plateau; intense volcanic activity was manifested in many parts of this area, and especially from the vicinity of Lassen Peak and Mount Shasta northward to the Columbia River and eastward along the Snake River to the Yellowstone National Park; and long faults, running mostly from north to south, divided the distended region into a multitude of orographic blocks, which, being soon allowed to sink, became tilted in their subsidence and form the present Basin ranges.

If we attempt to correlate these events with the Quaternary glaciation of the northern part of our continent, they seem to have been contemporaneous with the maximum extension of the ice-sheet of the first Glacial epoch. The ice accumulation I have attributed, on evidence derived from fiords and from river-channels now deeply submerged by the sea, to former great elevation of the glaciated areas, probably three thousand to four thousand feet higher than now. But the glacial and modified drift show that toward the end of each of our two principal Glacial epochs the land on which the ice lay was depressed nearly to its present level or in part lower. This depression of the earth's crust I believe to have been caused by the vast weight of the ice-sheets; and, in the first Glacial epoch, we have the correlative somewhat sudden elevation of a contiguous area, with outpouring of lava and formation of tilted mountain ranges, in the Great Basin and north to the Columbia. During the long interglacial epoch very thick subaërial deposits, called by Russell adobe, were supplied by denudation of the mountains and spread on the lower parts of the Great Basin and in the San Joaquin Valley; and the subsequent two flooded stages of Lakes Bonneville and Lahontan belong apparently to the second Glacial epoch and to a later or third epoch of glaciation in the northern part of the Cordilleran region.

Extending our view to embrace the entire belt of which the Rocky Mountains, Sierra Nevada, and Coast Range are parts within the United States, we see that it forms the western side of both South and North America. Its length from Cape Horn to Alaska is about ten thousand miles of a great circle, from which the irregular course of the chain is nowhere widely distant. These complex mountain systems, including the Andes, the mountains of Central America and Mexico, the Rocky Mountains and parallel ranges west to the Pacific, and the Alaskan mountains, may be together named the Andes-Cordilleran belt. In Bolivia and Peru the highest portions of the Andes are found by David Forbes to be folded Silurian strata, which are so associated with Devonian, Carboniferous, and Permian formations as to imply that the principal epoch of mountain plication there, as of the Appalachian system, was at or near the close of the Palæozoic era. But later epochs of plication are also recognized in portions of the Andes, as likewise in the rocks of the Sierra Nevada, the Wahsatch, and the Coast Ranges, in the western United States. Indeed, the last-named range, and the range which culminates in Mount St. Elias, the former stated by Whitney to contain infolded Pliocene beds, and the latter found by Russell to consist of Pliocene or early Quaternary rocks, were formed by very late mountain-building, perhaps correlative, like the faulting and tilting of the Basin ranges, with great movements of the earth's crust producing and accompanying glaciation. The present height of the Andes, as of the Appalachian, Atlantic, and Laurentian mountain systems, and the Cordilleran ranges of the west part of this country and Canada, must be ascribed to Tertiary and Quaternary upheavals of this belt, portions of which had long before and at different times been folded and raised to mountain heights, but afterward had suffered erosion almost or quite to a base-level.

5. Erupted Mountain Ranges.—Volcanic action has often been developed on a grand scale along the deep fissures and fault-planes which border and intersect tilted mountains and plateaus, as notably in the Andes and in Mexico, where it has built up very conspicuous volcanic cones of outpoured lavas and ejected blocks, bombs, lapilli, and ashes. Often, too, prolonged fissures, which may intersect each other (as in the Hawaiian Islands), reach down through the earth's crust to lavas that well up and build mount-

ain masses and plateaus, while the crust segments have been only slightly tilted and sometimes lie wholly beneath the sea-level. Such eruptions form the Cascade Range, the mountainous plateaus of Iceland and the much-eroded Färöe Islands, the Deccan plateau in India, the volcanic chains of the Sunda, Kurile, and Aleutian Islands, and the Hawaiian Island belt.

The Cascade Range is a typical example of this class, having an extent of more than 500 miles from south to north across Oregon and Washington, showing a thickness of nearly 4,000 feet of lava where it is cut through by the Columbia, and bearing here and there volcanic peaks which rise to altitudes 10,000 to 14,000 feet above the sea. The eruptions producing this range took place during late Tertiary and early Quaternary time, being contemporaneous with the faulting and tilting of the Basin ranges, the Wahsatch, and the Sierra Nevada, and with the folding and upbuilding of the Coast Range. As Jamieson and Alexander Winchell have well suggested, the outpouring of the vast lava floods of the Cordilleran belt in the United States, a portion of which forms the Cascade Range, was probably in large part or wholly dependent on movements of elevation and subsidence of the adjacent glaciated area. Another erupted range, on a smaller scale, but very interesting in its details as described by Russell, belonging to the Quaternary era, and partly to the recent epoch, lies close south of Lake Mono, in California.

6. ERODED MOUNTAIN RANGES.—The form and contour of nearly all mountains, excepting volcanic cones, have been given to them by the sculpturing agencies of subaërial denudation. This is true of each of the foregoing classes, where mountain-building energy has supplied the mass, but erosion has shaped the slopes, ridges, and peaks, the ravines and valleys. These five classes of mountain ranges have been sculptured by erosion, where previous mountain-building has raised limited areas to an exceptional altitude. But besides these orogenic upheavals, there have been broader uplifts of the whole or large parts of continents, which Gilbert and White have called epirogenic movements. The sixth class of mountain ranges, here to be noticed, is distinguished from all the preceding by its comprising mountains which owe their origin to no definite mountain-building process, being simply remnants of extensive areas which have been uplifted by epirogenic energy as great plains and since have been deeply eroded.

The plains which slowly rise from the Mississippi Valley and Manitoba westward to the foot of the Rocky Mountains afford examples of this type of mountain structure. Perhaps the most striking is the range of the Crazy Mountains in Montana, which lies immediately north of the Yellowstone River near Livingston, and is conspicuously seen from the Northern Pacific Railroad. These mountains trend slightly west of north, and extend about forty miles with a width of fifteen miles, attaining an elevation of 11,178 feet above the sea and 5,000 to 6,000 feet above the prairies at their base. Their structure has been thoroughly studied by Wolff, who finds that they consist of late Cretaceous strata, soft sandstones, nearly horizontal in stratification, intersected by a network of eruptive dikes. The more enduring igneous rocks have preserved this range, while an average denudation of not less than one mile in vertical amount reduced all the surrounding country to a base-level of erosion. The Highwood Mountains, about 25 miles east of Great Falls, Montana, having a height of 7,600 feet above the sea, or about 3,500 feet above their base, are described by Davis as displaying the same structure, and therefore similarly testifying of great denudation. This erosion of the Great Plains was probably in progress during the whole Tertiary era. Around Turtle Mountain, on the boundary between North Dakota and Manitoba, its amount was not less than 500 to 1,000 feet.

Original epirogenic uplifting of these plains took place at the end of the Cretaceous period, or during the early part of the Eocene. Thence onward through the Tertiary era, rains, creeks, and rivers were reducing this region nearly to the sea-level, excepting remnants like the Crazy, Highwood, and Turtle Mountains, which were being sculptured approximately to their present form. But the Tertiary era seems to have been terminated and the Quaternary ushered in by a new epirogenic differential uplifting of this continent, causing the accumulation of the ice-sheet of the first Glacial epoch. The time of great elevation initiating the Ice age, and the ensuing long interglacial epoch before the second glaciation, appear to have permitted rivers in North Dakota and Manitoba to wear away a considerable part of the Tertiary base-leveled plain, from its former eastern margin to the remarkable escarpment, in part a small eroded mountain range, of the Pembina, Riding, and Duck Mountains and the Porcupine and Pasquia Hills, which form the west border of the Red River Valley plain and of the lowland with large lakes in central Manitoba.

Reviewing this classification of mountain ranges for the purpose of discovering what elements of diversity and of unity characterize the manifestations of mountain-building energy, we see this to be of two kinds, the second being presented under four phases. The first kind of mountain-building energy, producing folds, is evidently lateral pressure, and is ascribed by geologists and physicists to the contraction of the earth's mass by its secular cooling, with resulting adaptation of the rigid outer part of the crust to the shrinking interior. The second is energy acting vertically upward, which has produced the four other types of constructive mountain ranges and masses by diverse phases of its manifestation—namely, the slow arching of limited areas, as the Uinta, Junction, and Yampa Mountains; the sudden volcanic lifting of the laccolite mountains; the upheaval and subsidence, with faulting and tilting, of the Basin ranges; and the outpouring of lava, as in the Cascade Range. Each of these four phases of vertically acting energy depends upon a viscous and plastic (neither solid nor perfectly liquid) condition of the earth's interior. Greater pressure of some portions of the crust than of others upon the plastic interior would induce each phase of upward energy in mountain-building. Where isolated blocks of the crust yielded slowly to the resulting quasi-hydrostatic pressure of the interior, mountains of the Uinta type were formed; but large areas, as the Great Basin, being swelled upward and anon subsiding, as the interior pressure increased and diminished, have become marked by tilted mountain ranges. Where the relations of intense heat, immense pressure, and chemical influences, with presence of water or its further ingress, have allowed portions of the interior, often of great extent, to become liquid lava, its extravasation by the same pressure has formed laccolite mountains and erupted mountain masses, while many volcanic cones have been mainly built up of fragments of solidified lava, much of it so fine as to be called ashes, explosively ejected.

In an appendix of Wright's Ice Age in North America, I have pointed out the source of the relationship by which these two kinds of mountain-building energy are united, both being caused by the earth's contraction in cooling, and the second or upwardly acting kind of energy being dependent on the first in the intermittent and occasional relief of stress of the earth's crust by its folding along the great orographic belts. Between the epochs of mountain-building by plication, the diminution of the earth's mass produces epirogenic distortion of the crust, by the elevation of certain large areas and the depression of others, with resulting inequalities of pressure upon different portions of the interior; and these effects have been greatest immediately before relief has been given by the formation of folded mountain ranges. There have been two epochs pre-eminently distinguished by extensive mountain-plication, one occurring at the close of the Palæozoic era and another progressing through the Tertiary and culminating at the beginning of the Quaternary era, introducing the Ice age. During the last, besides plication of the Coast Range, of the Alps, and the Himalayas, a very extraordinary development of tilted mountain ranges, and outpouring of lavas on an almost unprecedented scale, have taken place in the Great Basin and the region crossed by the Snake and Columbia Rivers. With the culminations of both of these great epochs of mountain-building, so widely separated by the Mesozoic and Tertiary eras, glaciation has been remarkably associated, and indeed the ice accumulation appears to have been caused by the epirogenic and orogenic uplifts of continental plateaus and mountain ranges. Since the disturbances, with glaciation, closing Palæozoic time, the same combination of events has not recurred until the Quaternary era, which is not only exceptional in its accumulation of ice-sheets, but also in its numerous and widely extended movements of elevation and subsidence, and in its mountain-building and renewed upheavals of formerly base-leveled mountain belts. The earth's surface is probably now made more varied, beautiful, and grand by the existence of many lofty mountain ranges than has been its average condition during the previous long eras of geologic history.

MUSICAL INSECTS.

By HERR R. FRANCHESCHINI.

IF we would hear the children of the sun, we must shut the door of our prosaic room behind us, and hurry out before the coming on of dusk to the pond, into the green field, on the moor, to the edge of the wood where life in the double form of animal and plant unfolds itself without restraint. From up in the air, from plants, flowers, grass, holes in the ground, and the moisture of puddles, come a chirping and rattling, a humming and buzzing, a piping and singing of the host of winged and wingless creeping and hopping insects. Let us guard our steps. Near us a musk-beetle is groping with his long, knotty feelers along the bark of a willow tree. The shrill tone of his chirp strikes upon the ear; and if we are gifted with musical sense enough we may succeed in hitting the key-note of his register. We need only use our chamber-tone, the treble A, or any other note easy to whistle, in order to determine from it the pitch of the beetle's song. We shall find then that he has the highest-pitched voice in all Nature's concert—the third octave of D. From the distance comes a humming which is related to that chirping as the alto to the treble. It is the sound of the vibrating wing of the moss-bee. The buzzing bass of the bees and wasps is about an octave lower than our chamber-tone A. Within this melodic compass, or the musical space of three octaves and a quarter, lie the voices of all the other crawling six-footed symphonizers. How is all this music produced? Men and the higher animals have lungs—the bellows; a windpipe; a larynx, the real sounding instrument; and, as mouth-piece, the hollow of the throat and mouth. How can insects, too, execute vocal music? The answer is simple: no insect has what we in the proper sense call a voice. They produce their music either like our bumble-bee, by the mere vibration of their wings, or they have some special apparatus which they adapt to musical efforts, the peculiarities of which we are about to learn from some of them.

As we continue our walk, our feet, treading down the grass, cause a lively disturbance, like that which Gulliver raised among the Lilliputians. Every sort of frightened thing, large and small, hops up and down in front of us, behind us, to the right and left. But, out of the confusion of sounds that accompany the disturbance, there strikes upon us, over-sounding all, a sharp rattling—every child knows the musician—the green jumper of the meadows, the grasshopper. What is the instrument that this animal plays upon? The grasshopper is a real fiddler. To satisfy ourselves of this, we have only to catch one and examine him closely, to find that he carries the instrument on which he plays upon his thigh. In our picture (Fig. 1) the inner side of the grasshopper's thigh is represented as turned toward us, and over it is drawn a curious skin. If we bring a section of this skin under a microscope

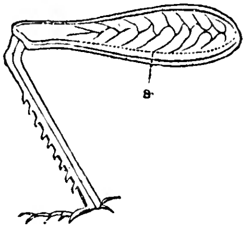

Fig. 1.—Grasshopper's Leg (magnified three times).

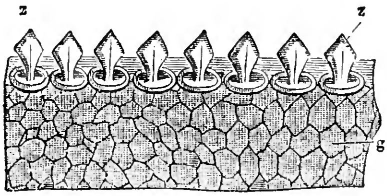

Fig. 2.—Toothed Skin of the Grasshopper's Leg (magnified one hundred times).

magnifying about a hundred times, we shall perceive that the cellular tissue of which it consists is furnished with several small teeth (Fig. 2). They are not much longer than a hair is thick, but there are eighty or ninety of them. This system is the grasshopper's fiddle-bow. The insect has other peculiar formations on each wing; these, however, have no teeth, but are even, and project as an edging along the wing. When the grasshopper would make music, he rubs his fiddle-bow rapidly backward and forward over this process, and there arises the well-known rattling sound, such as one can produce with a bow upon loosely strung violin-strings. The tone, which is strengthened by the action of the wing as a resonance membrane, is not the same with every individual. We hear, sometimes the first, sometimes the second violin, sometimes the bass-viol; and Handel seems to have had the last especially in his mind when, in his Oratorio, Israel in Egypt, he attempted to represent the rushing of the swarms of locusts which afflicted the Nile country as the seventh plague, by a principal viola.

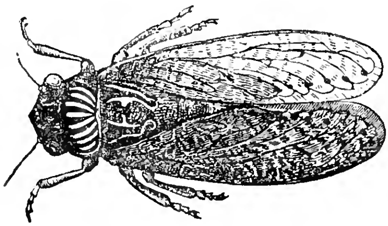

FIG. 3.—CICADA.

Several other species of insects have apparatus for producing sounds similar to that of the grasshopper, or modifications of it. Of a different type is that with which the cicadas (Fig. 3) are endowed—the only creatures of this class which have vocal apparatus analogous to those of the higher animals. Only the males of this family are singers, for which the Greek poets called them happy because their females were dumb. With the ancients, a cicada sitting on a harp was the symbol of music. A pretty fable tells of the contest between two cithara-players, in which the curious event happened that when one of the contestants broke a string, a singing cicada sprang on his harp and helped him out so that he gained the prize. The Greeks, who shut the insects in cages so as to be sung to by them in their sleep, were at odds concerning the nature of their singing apparatus; and the controversy among naturalists on the subject lasted till very recently. The zoölogist H. Landois, who investigated the difficult subject of animal sounds with ceaseless industry and great skill, was able to give a satisfactory solution to the question. According to his research, the case is one in which the sound is really made by air circulating through passages in the interior of the body. Every insect's body is penetrated by a system of breathing-tubes or tracheæ which open at places on the surface. The openings are called stigmata. This system of breathing-tubes, through which the air is inspired and expired, takes the place of the lung of the higher animals. Landois discovered them in very obscure parts of the cicada, and found that they form a kind of windpipe representing the actual tone-factory of the animals. This air cavity is, as the picture (Fig. 4) shows, not quite open, but has only a narrow cleft (*sp*), through which the air goes in and out. The cleft is formed by two stretched membranes (*sa* and *sb*), which vibrate when the air passes through. They serve, in fact, a like function with the vocal cords of our larynx. They lie, besides, opposite a large cavity over which a folded membrane is stretched like a drum-head upon a hard

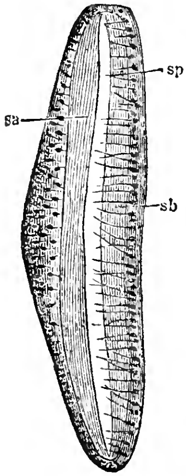

FIG. 4.—TONE APPARATUS OF THE CICADA (magnified thirty times).

ring, and which, when the vocal cords begin to vibrate, vibrates with them and serves as a resonance apparatus. Although there is no real voice, which with us is inseparable from a mouth, we can say that the cicada comes nearest among insects to having such a gift There is a curious relative of our cicada in America, which in its larval condition exhibits a phenomenon that nothing else is like. The larva lives in that form fully seventeen years under ground before it assumes the shape of a perfect insect. It has been called by the characteristic name of the seventeen-year locust. The voice of this locust was heard on board the Beagle, in which Darwin made his famous voyage, an English mile off. Its song is essentially a trill of the treble E with D sharp, then a run down the chromatic scale and rapidly up again, about such a strain as one would play if he slipped his finger up and down the string of a violin while drawing the bow over it. The musical reader may gain from the following an idea of the talent as a composer, and of the song of this locust:

With most musical insects there is no special apparatus for the production of tones. They simply combine the useful with the agreeable. The wings that bear them through the air also make the sound-waves. The only remarkable thing is, that the flying-tones thus produced are so different in single kind. The wings of the bee, for example, vibrate four hundred and forty times in a second—the same number of vibrations as in our normal tone; it is the music-master, and is the cleverest and best esteemed of insects. In other bees, as the female bumble-bee, the wings vibrate eight hundred and seventy times in a second, and sound the treble A, an octave higher than the bee. Marey, who has succeeded in photographing the flight of birds, has also found an ingenious method of determining the number of vibrations of insects' wings. He fixed a fly so that the extreme tip of its wing touched a soot-blackened cylinder, which could be turned by clock-work upon its axis. Every stroke of the wing made a faint but perceptible mark, by means of which Marey was able to determine that the fly made three hundred and thirty wing-beats in a second.

As we sit at night by the lamp, there arises suddenly a loud humming tone, alternately swelling to considerable strength and diminishing till it is barely heard, until the musician, a large blue-bottle fly, to our annoyance darts humming against our cheek or hand, or precipitates himself into the lamp. Every reader has had occasional opportunities, of which these are instances, to enjoy the study of such examples of the capacity of insect sounds to make music.—*Translated for The Popular Science Monthly from Ueber Land und Meer.*

ESKIMO BOATS IN THE NORTHWEST.

By JOHN MURDOCH.

As we came in sight of the Eskimo village at Cape Smyth, late in the afternoon of September 8, 1881, some one called out that a boat full of natives was coming off under sail to meet us. We all rushed to the rail, eager for the first sight of our future neighbors, and saw running down before the wind a large boat shaped like a fisherman's dory, with one mast and a single square sail, of blue drilling, which looked almost black through the mist.

As she neared us the sail was taken in and the mast lowered, but the strong wind drifted her past us, and all hands were soon busy with their paddles driving her up against the wind till they were near enough to catch a line thrown from the schooner and gradually haul the boat alongside. A strange party they were as their boat was towed astern, dancing in the waves, while we crowded to the taffrail to look at them, and hail them with the few words of Eskimo that we knew.

All were dressed in deer-skins, over which many had drawn water-proof hooded frocks made of the entrails of the seal, while others wore outside gay frocks of calico, fluttering in the strong breeze which blew back the long hair from the men's foreheads.

All were grinning and shouting, and very strange to us looked the curious *labrets* or lip-studs which all the men wore at the corners of the mouth, like a couple of large sleeve-buttons stuck through holes in the under lip.

But the strangest of all was the boat they were in. About thirty feet long and six feet in the beam, she was merely a skeleton of wood covered with skin tightly stretched across this frame. This was the big family boat, used for traveling and the chase of the whale and walrus, the *umiak*. Like all the Eskimos who have boats at all, and but very few do not use them, the Eskimos of Point Barrow and Cape Smyth use two kinds of boats: one called an *umiak*, a large open boat capable of holding fifteen or twenty people; and the other called a *kayak*, which holds only one man, and is very like a racing shell boat or one of our "Rob Roy" canoes, which, indeed, were modeled after the Eskimo *kayak*. It is narrow and sharp, and decked all over except a round hole in the middle where the man gets in and sits with his legs under the forward deck.

All the Eskimos, except perhaps some of them who live in the wooded regions of southeastern Alaska, who are said to use birch-bark canoes like the Indians, cover their boats with the skins of marine animals, using the skins of the larger seals for the *umiak*, and those of the small seals for the *kayak*.

It is no small undertaking for a man at Point Barrow to collect wood enough for the frame of an *umiak*, for he has only the drift-wood on the beach to select from, and the larger parts are often elaborately pieced together. When a suitable stick for making a stem or stern-post is found, the finder marks it for his own—and it is the unwritten law of the community that such marked property shall be respected—and when he has leisure goes out with his little adze and works away at it on the beach till he has hewn it into shape before he brings it home.

When he has at length collected all the pieces for the frame, he begins to put them together, without using a single nail in the whole structure. The heavy parts of the frame are neatly mortised together and secured with wooden pegs, while the lighter parts, such as ribs and gunwales, are secured by regularly sewing them with long, thin strips of whalebone, which are run through holes drilled in the two parts to be united.

The following pieces make up the frame of the *umiak:* Along the middle of the bottom runs one long timber, to the ends of which are scarfed the stem and stern-post, made of natural knees, and slanting so that the top of the boat is longer than the bottom. The top of each part is widened into a square block. This makes a high seat for the steersman in the stern and a sort of shelf in the bow. On each side of the bottom is another stout strip of wood, deeper than the keel, which make the edges of the flat bottom, being bent in and scarfed to the stem and stern-post, but spread apart amidships by the floor timbers, which are laid across the keel inside, but mortised into these side strips. There are a dozen or fifteen floor timbers, longest, of course, in the middle of the boat.

From the side strips rise fifteen or twenty pairs of ribs, fastened on with lashings of whalebone. These slope out a good deal amidships, but grow more nearly vertical toward the bow and stern. On the ends of these ribs are lashed the gunwales, round poles about two inches in diameter, running from bow to stern on each side. These run out beyond the stem and meet in a point, but only project a little beyond the stern-post. Along the ribs inside, about half-way down, is fastened a stout strip of wood on which the seats or thwarts, seven or eight in number, are secured, and to strengthen the frame still more another strip is fastened on outside of the ribs.

When these pieces are properly put together we have the framework of a long boat, with a broad, flat bottom, sharp ends, and flaring sides, with a good deal of "sheer" to the gunwales—that is, with the edge of the boat running up at the bow and stern. To cover this frame they sew together, with an ingenious water-proof double seam, skins of the walrus or the great bearded seal which have been deprived of their hair and dressed with a little of their natural fat, so that they are quite water-proof.

Skins of the bearded seal make the best boat covers, and six good-sized ones are enough for one boat. When the cover is ready it is thoroughly wet and stretched over the frame, the edges being drawn over the gunwales and laced to the strip which supports the seats. Of course, when the skin dries, it shrinks as tight as a drum.

To propel these boats they have a square sail, used only with a fair wind, broad-bladed paddles, and ridiculous little narrow oars, which the women pull with great vigor, but to very little purpose, never keeping time or stroke. The mast stands on one of the floor timbers nearly amidships, and is held up wholly by four stays, two forward and two aft. When the sail is not in use, mast and all are taken down and laid in the bottom of the boat. In traveling along the shore, to save the trouble of paddling, they often harness up three or four dogs and make them trot along the beach, drawing the boat by a long tow-line.

In these boats they chase the walrus, the white whale, and, most important of all, the great "bowhead" or polar whale, from which come the whale oil and whalebone of commerce. In them, too, they make long journeys along the coast in summer, carrying their tents and all their household goods, and sometimes go two or three hundred miles to trade with other Eskimos.

This boat is in no way exclusively a "woman's boat," as it is in Greenland, though the women use it as well as the men, but it is the boat for general use. Nearly every head of a family, unless he is very poor indeed, owns an *umiak*.

In winter the leather cover is removed and put away in a place of safety, and the framework carefully laid up, bottom up, on a special scaffold out of reach of the dogs.

Though the *umiak* is not a "woman's boat," the *kayak* is the man's boat *par excellence*. The Point-Barrow Eskimos, however, do not use *kayaks* as much as some others, especially the Greenlanders. All the men, however, and most well-grown youths own *kayaks* of very good model, and can manage these ticklish craft very skillfully, though they can not compete with the Greenlanders.

Kayaks are mostly used during the summer journeys and for pursuing swimming reindeer and wild fowl on the lakes and rivers. These canoes are very narrow and easily capsized. One which we brought home, and which is now in the National Museum at Washington, is nineteen feet long with only eighteen inches beam, and is just deep enough to hold a man's legs under the deck, which is arched for a short distance forward of the hole. It weighs only thirty-two pounds. The framework of the *kayak* is very light. The stoutest of all the parts are two strips or gunwales, one on each side, about three inches wide and half an inch thick, kept apart by slender deck-beams, which are longest, of course, in the middle of the boat. The ribs are hoops bent into the shape of the letter U, and there are forty or fifty of them mortised into the lower edge of the gunwale, while they are kept in place by slender strips of wood lashed along outside of them from stem to stern. A stout deck-beam across the back of the hole for the rower to lean against and a hoop round the edge of the hole complete the frame of the boat. It is all fastened together, like that of the *umiak*, with wooden pegs and lashings of fine whalebone. Such a boat is covered with five or six skins of the smallest seal, carefully dressed with the hair and black epidermis or outer skin removed. These skins when freshly prepared are of a beautiful cream-white color, which soon turns, however, to dull yellow. These six skins are sewed together side by side, the head of one skin to the tail of the next. Then the cover is thoroughly wet, the boat is laid down on it, and the edges of the cover stretched up over the deck as tightly as possible and sewed together in an irregular seam, running lengthwise along the deck. Finally, the edges round the hole are stretched over the hoop and firmly laced with a thong. This finishes the boat, except for making some loops on the deck fore and aft to hold spears and such things, or whatever load the man may wish to carry.

When a Point-Barrow Eskimo is simply traveling along and does not care to make any great speed, he uses an ordinary paddle with one blade, like those used in the *umiak*, but somewhat lighter. As he has to sit in the very middle of the boat, he can not use this as an Indian would, wholly on one side, driving the boat ahead with straight strokes and overcoming the tendency of the canoe to go off to one side by feathering his paddle in the water or by an outward sweep of the blade. First he makes three or four strokes, say, on the right side, and then, as the boat begins to sheer off to the left, he lifts the paddle out of the water and makes three or four strokes on the left side till she begins to sheer to the right, and so on. They do this pretty skillfully, so that the boat makes a tolerably straight "wake," and goes through the water at a pretty fair rate, but, of course, can make no great speed.

When the time comes for hurry, out is drawn from under the deck the double-bladed paddle, such as we are all familiar with from the writings of Captain Ross and Captain Parry, Dr. Kane, and all the explorers who have visited the Eskimos of the eastern regions. This is about six feet long and has at each end a broad, oval blade, far more serviceable than the narrow oar-blades of the eastern *kayak* paddles. The man grasps this by the middle and dips each blade alternately, regulating the force of his strokes so that the canoe goes straight through the water without veering to right or left. With the double paddle the *kayak* can be made to fairly fly through the water.

A reindeer caught swimming in a lake (the deer often take to the water in summer to escape the plague of gnats and gadflies) has little chance of escaping. The swift *kayak* soon overtakes him. The hunter has already pulled from its loop on the forward deck one of his pair of light lances and has it lying loose on deck, the butt resting on the loop in easy reach. As he ranges alongside his victim he catches it up—a quick downward thrust, and the deer floats a lifeless carcass.

It requires no small skill to manage one of these little craft without upsetting, but the boys begin to learn at an early age, so that balancing grows to be a second nature, and the *kayak* man is as much a part of his boat as a good rider is of his horse. Getting into a *kayak*, even, is an art in itself. I once watched a couple of young fellows launching their boats in the lagoon close to our station. A place was selected where the bank was steep, but not high, say about a foot above the water, while the water was just about deep enough to float the *kayaks*. Then the boats were carefully laid in the water alongside of the bank—it would not do to shove them in over the gravel or allow them to scrape on the bottom, they are so delicate—and held in place by sticking down the blade of the paddle into the gravelly bottom on the outer side of the canoe. Balancing himself by holding on to the handle of the paddle with his left hand, each man cautiously lifted his left foot, and wiping it perfectly clean of sand and gravel with his disengaged right hand, carefully stepped into the canoe. The right foot was then raised with equal care, wiped, and inserted into the hole.

Still balancing himself with the paddle, each man adjusted his clothing, carefully sat down, thrusting his legs under the forward deck, and settled himself in position. A gentle shove-off from the shore, a stroke or two of the paddles, and they were off.

The Eskimos are always very careful to avoid getting any sand into either kind of boat, for it works down among the timbers where it can not be cleaned out, and, gradually getting between the skin and the framework, soon cuts through the former.

Both kinds of boats are always drawn up out of the water, except when in actual use, and the *kayaks*, like the *umiaks*, are always stripped for the winter.

In summer the men often make quite long excursions across the country after reindeer, traveling mostly on the lakes and ponds, crossing from lake to lake with the *kayak* carried on one arm, which is thrust into the hole up to the elbow, with the hand grasping the frame inside. The trading-parties that go east in the spring start before there is any open water along the shore at Point Barrow, and travel along the level shore-ice with the *umiak* lashed to a flat sled drawn by the dogs and all the men and women. Tent, *kayaks*, and all the baggage of the party are loaded into the *umiak*, and so they travel on till, in about two days' journey from the Point, they find the open water which has come down from the great rivers. Then they land the sledges, to be picked up on their return in the autumn, launch their boats, and proceed on their journey by water.

The *umiaks* are first launched about the middle or end of April, when they are dragged on sledges out over the ice to the off-shore open water for the spring whaling. They are constantly in use from that time, whenever the ice will permit, till well into October. The *kayaks* are seldom brought out till the ponds are free of ice—about the 1st of July—but the middle of October generally sees all boats of both kinds laid away for the season.

TAKE CARE OF THE BIRDS!

By Dr. KARL RUSS.

ON an unprejudiced view of the matter, we may well be surprised that a barbarity so foreign to the aspiring tendencies of our age as the destruction of birds should continue; that exhortations to protect them are still necessary; and that active harboring and care of them are not matters of course. There are special causes for the lamentable existing conditions, but a wide survey is necessary to the full understanding of them. If we seek for the causes of the lessening numbers of our wild birds, including the finest and favorite singers, we shall find that they are many and interwoven. Foremost among them are the conditions of modern cultivation. When denudation is the rule in forestry, and the whole growth is cut away with all the old and hollow trees and those that were rich in knot-holes; when agriculture, making the smallest spot of ground productive, roots out stumps and hedgerows, dries up the swamps, drains the larger ponds, and regulates and straightens the streams, clears the shrubbery from pastures and meadows and groves, and trims gardens and orchards with a view to the largest crops, the birds can find no homes or nesting-places, and of course can not thrive.

In our neglect of care for birds we have failed to keep in check their natural enemies, which are able to do relatively more damage than ever before. These include four-footed beasts, birds of prey, thieving birds, and our own domestic cats and dogs, with rats; to which may be added the hardships of weather, that bear more severely upon birds than in former times, because of the removal of the sheltering woods under which they could once cover themselves, and the modern bird-killing inventions of telegraph wires and electric lights.

The capture of birds for pets is a factor of a little importance in promoting their disappearance; hunting them as game is a more important one; while the destruction of birds for the sake of their feathers, whereby women may gratify their desire for show, has reached a frightful extent.

Before considering what measures may be taken to obviate the danger of extermination to which birds are exposed, it is proper to inquire what these creatures signify in our economy, and whether their preservation is necessary or desirable.

To my mind, the highest value of our wild birds—I speak of birds in general, while I refer especially to those smaller creatures which we describe as song birds—lies not in the useful service they may do to us, although that is not to be underestimated. I am still of the opinion, which I expressed more than a quarter of a century ago, that their æsthetic influence, the effect they exert upon our spirits and in developing our sense of beauty and our appreciation of all that is pleasant and lively in Nature, is of much higher value. We could hardly imagine a landscape of our country, with its alternations of hill and valley, field and wood, pasture and meadow, threaded with streams or dotted with lakes, not enlivened by nimble birds. How bare and empty would our orchards appear, even in the splendor of their spring bloom, without the twitter, the clear songs, the joyous melodies, and the cries of the robins, bobolinks, cat-birds, and blackbirds that haunt them! For any real enjoyment of Nature, we must have the brisk, songful, and noisy bird-life around us. Further than this, we can not doubt that birds, in freedom as well as living with us in our rooms, may be a means of instruction lasting through life, and exercise a profound influence upon youth, by awaking in them an interest in natural life, and leading them to the enjoyment and love of all that is in Nature, particularly in its animal and bird life, and thus eventually to become students of its works and phenomena. In large cities the birds and the flowers are not rarely all that is left to guard men against being fully estranged from Nature.

But in consideration of the fact that in the materialistic tendencies of our day to turn away from all purely idealistic points of view, and notwithstanding what has been said above, since the main argument for the protection of birds lies in their importance and indispensability for Nature's household and for human welfare, I will also take their actual usefulness into consideration. We dismiss those excessive exaggerations by which each and every bird is represented as necessary. They have done more harm than good to the cause by the sharp and sometimes angry contradictions they have provoked. To designate all birds according to their usefulness or the harm they do would be hopeless; for each bird, even the most useful, may under some circumstances do much harm; so that the useful or injurious character of single species may be exceedingly variable under different local conditions. I may be allowed to adduce a few examples of this.

The sparrow has been of late years one of the most noxious of all birds; and is capable, in fact, in districts under high cultivation, alighting in hosts on fields of ripening grain, or in orchards, of doing great harm. Nobody can, on the other hand, deny that it eats naked caterpillars, worms, and similar vermin; and whoever will can without difficulty satisfy himself that it eagerly catches grub-worms in the spring. The complete extirpation of the sparrow, which is recklessly and improvidently demanded in many quarters to-day, would be a serious wrong and great folly, because it is in many places the single bird destructive to vermin, and the latter would without it increase much faster and become more predominant than hitherto. A similar view may be taken of the bull-finch, whose beauty every one enjoys wherever it shows itself; but it is one of the class which men would banish, for it has in many places developed great power for mischief. It eats the flower-buds from the fruit trees, especially from the pear trees, and thus does great harm. And it is fortunate that in many parts of Germany its young are stolen from the nests by hundreds, domesticated and trained to be singers, and have become an article of trade. Blackbirds and starlings have likewise come to be regarded as obnoxious by narrow-hearted gardeners who look at everything through the spectacles of their own interest. In other respects these birds are among the most useful we have. If we were to estimate the usefulness or objectionableness of all birds, giving heed to the prejudices of every one whose special interest they might in some way damage, we should have to put the ban upon nearly all, and have hardly a species exempt from sentence.

Instead of this, we prefer to apply the measures by which we may effectively protect our birds in general, so as to preserve them as far as is possible under present conditions.

Against the most important cause of the disappearance of birds, modern agriculture and the removal of the forests, special measures have been adopted with effect in some places, and more are needed. Among these are the plantation of sheltering woods, particularly in or near cities, in public parks, and on all estates, and of thickets in the open fields. These should contain abundant berry-bearing plants and thorny bushes, and might be thickly furnished with nest-boxes, such as are made at several German factories, after patterns indicated by Gloger, in six different numbers. An essential condition to the success of such bird-protectories is the suppression of all enemies of birds and of all disturbers of their nests, egg-collectors large and small. The weakest efforts in behalf of the birds have been those to protect them against unfavorable conditions of weather. Happily, excessive severities of weather, like hard hailstones and terrible thunderstorms, in which birds are numerously sacrificed, are comparatively rare. Lesser weather changes, while they are often not less dangerous to birds, we can more easily contend against. Certainly, any sincere lover of birds, even though he have only a garden or a small yard, or a balcony or a window, can set out food for the support of feathered guests in times of snow or hard frost. But perhaps only a few friends of birds think of the times when the weather conditions are really most unfavorable, and the care of them is most needed. In the late snows and sharp frosts of approaching spring, many of our feathered summer friends are exposed to great hardships, in which they need all the attention that their friends can give them.

The taste for having singing-birds in the house is so wide-spread and so deeply rooted in popular life that it would be hard to extirpate it. No intelligent man would underestimate its influence on the temper, or its educational, moral, and economical importance, and no well-wisher could desire its complete suppression. And it is demonstrable that bird-catching for the sake of this fancy hardly contributes materially to the diminution in the number of birds. It affects chiefly the males, which among native birds greatly outnumber the females; and when a hunter catches a male of almost any species, another will appear in a short time to fill its place. Egg-collectors, on the other hand, may inflict great damage; and the collector of the present time is not satisfied with one specimen, as formerly, but usually takes the whole laying.

The form of destruction most grievous to thoughtful and sensitive men is that which is pursued for the sake of woman's adornment. It seems hardly possible, at the first look, that an honorable woman, possessed of a delicate, moral, pure, and true feeling, can find any pleasure in ornamenting herself with a dead bird, whose joyous and harmless life has been cruelly extinguished for her sake. Yet it is a sad fact that thousands of women go around with decorations thus procured, and hundreds of thousands of lovely and useful birds are killed for them. Against this neither words directed to the understanding, lessons on the value of birds, nor warnings appealing to the heart, are of effect; human vanity prevails over all, and triumphant fashion comes off victor. Nothing promises to be effective against it but a positive legal prohibition. Will not our intelligent, warm-hearted women come out with tact and decision against this abuse, and exert their influence upon the wider circle of those who are less judicious but mean well?

Happily, it is among most men only thoughtlessness and consequent indifference, and in only a narrow circle sheer selfishness, that has permitted the neglect or refusal of effective protection to birds.—*Translated for the Popular Science Monthly from Ueber Land und Meer.*

SKETCH OF GEORGE LINCOLN GOODALE.

GEORGE LINCOLN GOODALE was born at Saco, York County, Maine, August 3, 1839. His father, Hon. S. L. Goodale, for about twenty years the Secretary of the Maine Board of Agriculture, is widely known as the author of a standard work on the Breeding of Domestic Animals, and as an agricultural chemist. His mother was a lineal descendant of Rebecca Towne (Nourse), of witchcraft times in Salem.

During his preparation for college, he served as apprentice in an apothecary-store, his grandfather's business, and acquired a good knowledge of the pharmacy of that day. He entered Amherst College in 1856, and graduated in 1860 in the class with Prof. Estey and President Francis A. Walker. After graduation, he remained for a year connected with the college as assistant in chemistry and botany. His teacher in the latter department was the late Prof. Tuckerman. In Tuckerman's Catalogue of the Plants of Amherst and Vicinity the author refers to the excursions made with Mr. Goodale during the years from 1856 to 1861. Among the other teachers then in Amherst College who exerted a marked influence upon the tastes and work of Mr. Goodale should be mentioned the late President Edward Hitchcock and his son Charles, now of Dartmouth, Prof. C. U. Shepard the mineralogist, President Seelye, and the venerable Prof. William S. Tyler.

Being a rapid short-hand writer, he was at one period in his college course amanuensis to the late President William A. Stearns, with whom to the very last he maintained close relations. In his senior year he began the study of medicine with the well-known and beloved physician Dr. A. Smith, of Amherst, but toward the end of 1861 joined the Portland School for Medical Instruction as a pupil, attending courses of medical lectures in the Medical School of Maine and at Harvard. He received his medical degree at Harvard University in 1863, reading at graduation, a thesis on *Anthrax maligna*. Later in the same year he was given the same degree by Bowdoin College. From this date until 1865 he practiced medicine in Portland, served as City Physician, and gave lectures in the medical school on anatomy, and afterward on surgery and materia medica. During the winter of that year he attended as private pupil, in New York, the special classes of Dr. Frank Hamilton, Austin Flint the elder, and Dr. Shrady; but in February of 1866 his health was so much impaired that he relinquished practice and study, and went by the way of Panama to California. After having executed certain commissions in the inspection of mining property, he visited the principal points of botanical interest in the State, ascending Mount Shasta with a party in August. He made the ascent of the mountain with so little discomfort that he regarded his health as thoroughly re-established. His journey home in autumn was made by the way of Washington Territory, Idaho, Utah, and Colorado, the last part of the long stage-ride being by the "Smoky Hill" route in Kansas the week after the Indian raid of 1866. For a portion of the way the stage party found only smoking ruins of the ranch houses, but no Indians were met with.

In the following year Dr. Goodale visited Europe with his lifelong friend, Prof. Brackett, formerly of Bowdoin College, and now of Princeton University. He accepted, in 1868, an instructorship in Bowdoin College and the Medical School of Maine. His connection with those two institutions lasted until 1871, during which period he held the chair of Materia Medica in the Medical School, and of Applied Chemistry and Natural Science in the college.

At the invitation of Prof. Asa Gray, he became assistant in botany in the Summer School of 1871, and later in that year was appointed university lecturer in Harvard. In 1872 he was promoted to the Assistant Professorship of Vegetable Physiology, and in 1877 to the Professorship of Botany. On the death of his teacher, the late Asa Gray, he was appointed to the vacant Fisher Professorship of Natural History.

Many of his vacations have been passed in Europe in the study of economic and physiological botany, the vacation year of 1881–1882 in the laboratory of Pfeffer, in Tübingen, and in Paris.

Harvard professors are expected by the corporation of the university to perform more or less work indirectly connected with their own departments. That which has fallen to Prof. Goodale's share may be inferred from the following, taken from the last college catalogue: member of the Council of the University Library; member of the Faculty of the University Museum; and, next year, as President of the Boston Society of Natural History, he must act *ex officio* as one of the Trustees of the Peabody Museum. He is also Director of the Botanic Garden of the university.

In addition to the degrees already mentioned, Prof. Goodale has received that of Master of Arts from Bowdoin and from Amherst; from the latter also that of Doctor of Laws.

Among the societies to which he belongs may be mentioned: Phi Beta Kappa, of Amherst; American Society of Naturalists (of which he has been president); American Physiological Society; Society of American Anatomists; the German Botanical Society; the Academies of Philadelphia and of New York; the American Academy of Arts and Sciences; and the National Academy, Washington. He is this year the outgoing President of the American Association for the Advancement of Science.

Prof. Goodale's contributions to science have been chiefly physiological and botanical. In addition to these publications, reference may be made to his work as associate editor of the American Journal of Science, and to his three series of lectures before the Lowell Institute in Boston.

By his activity as a teacher and lecturer he has been successful in exciting a good degree of interest in his department in the city of Boston, and he has been enabled in this way to secure large sums of money for the Botanical Garden, Herbarium, and Museum. By a recent university report it appears that the subscriptions to these objects, within ten years, have reached the sum of one hundred and sixty thousand dollars. With a portion of this money there has been built an extensive addition to the Agassiz Museum, which accommodates amply the magnificent cryptogamic collections and commodious laboratories of Prof. W. G. Farlow, the laboratories of morphological, physiological, and economic botany, and the museums of botany. For the purpose of augmenting the material for the latter, Prof. Goodale has just completed a journey to Ceylon, Australia, Tasmania, New Zealand, Java, Straits Settlements, Cochin-China, China, and Japan. The fruits of this very zigzag tour around the world are beginning to arrive from Victoria and Queensland. Arrangements have been completed by which large collections of objects illustrating the commercial botany of the present day are to be obtained from the principal countries of Europe and the East, and from the southern hemisphere.

But that part of the museum which has absorbed most of Prof. Goodale's thoughts for the last few years is the novel collection of glass models now in process of formation. Every visitor to our large collections in the natural history museums in the great cities has been struck by the marvelous beauty and fidelity of the models by the Messrs. Blaschka, of Germany. The more delicate marine invertebrates, illustrated in glass in this way, appear to be floating in their native element. By successful negotiations with the Blaschkas, Prof. Goodale has been able to secure for the Botanical Museum at Harvard equally beautiful and faithful models of plants and their parts. The results of the artistic feeling of these wonderful artists are simply beyond belief. The plant in flower and bud lies before the spectator as if it had just been taken from the garden or the field. There is not the least suggestion of glass about it. Every minute point has been copied by the artists without the slightest stiffness, and every shade has been given its true value. All the details of structure are given as they would appear under the microscope. In short, the success of the artists has been far beyond what they themselves dared to hope at the outset, and they are now employing all their time in the studies and plastic manipulations by which these creations are produced. By occasional visits to the home of the Blaschkas on the Elbe, and by providing them with a suitable botanical garden at their own door, Dr. Goodale has been able to indicate the range of the work, and to select the American plants to be copied. The enterprise contemplates the use of the exclusive time of the artists for nine years to come, and will involve at least one journey to Mexico and South America by the younger Blaschka. Two ladies of Boston have provided the funds by which this magnificent gift to Harvard University and to botanical science is rendered possible. The collection is to be in memory of the late Dr. Charles E. Ware, of Boston, an enthusiastic lover of natural history. The collection is now accessible to the public, and it will soon be provided with a descriptive catalogue in preparation by Dr. Goodale. The discovery that these remarkable German artists possessed the skill to prepare in permanent glass perfectly faithful copies of flowers and the parts of flowers, and the securing of this skill for his university and for America, may be fairly regarded as an important achievement in a busy life.

Notice is taken by a correspondent of Garden and Forest of a curious peculiarity of the dandelion. Its flower-stalks stand upright till the time of blossoming is past; then bend downward, assume the form of a double curve with the head close to the turf, and in a few days, having greatly increased in length, rise into the air several inches above the height of the original flower, where their ripened, feathery seeds enjoy a free exposure to the winds.

EDITOR'S TABLE.

THE WARFARE OF SCIENCE.

OUR readers have had the opportunity of following, in the interesting articles contributed to this periodical by Dr. Andrew D. White, the marvelous history of the struggle which science from its birth has had to wage with the forces of intellectual obstruction. The great foe to science, it is not too much to say, has been theology. To say this is not to cast doubt on the possibility of a true theology; it is merely to affirm that, in point of fact, the particular theologies that have heretofore occupied the ground have one and all felt themselves threatened by science, and have set themselves to resist its advance by every means in their power. We see no reason why this fact should not be frankly recognized. In the natural course of things theology deals in imaginative fashion with questions of origin and development; and until exact knowledge begins to prevail the notions thus established serve a more or less useful purpose. As knowledge grows, these conceptions are found to be faulty; but theology resists any change—in the first place, from a general conservative instinct, and, in the second, because the cause of moral and social order seems to be more or less involved with the primitive cosmogony. But when once man has begun to observe, to compare, to verify, and to record, he has laid a foundation that can not be shaken, he has sown a ferment that must grow and spread till it has leavened the whole of human thought. Systems founded upon imagination must yield to those produced by the use of the reasoning faculty. They were no better than guesses at the first; and if they furnish an adumbration, however vague, of the truth, it is almost more than we have any right to expect. Reason itself errs in many of its constructions, but it faces the light, and year by year and age by age it is able to perfect its work.

We fail, therefore, to see why any of our religious contemporaries should take in evil part the really instructive treatment which Dr. White has given to this subject of the perfecting of science through opposition and conflict. They really need not feel too bad about it. In a certain way it was good for science, just as it was for the Psalmist, to be afflicted. The natural reluctance which men of science felt to find themselves at variance with established beliefs, armed with the power of persecution, led them to scan their theories very carefully before giving them to the world. Moreover, the very difficulties of the situation drew out much heroism of character, and made science more conscious than it would otherwise have been of its moral and intellectual mission. Whether in these comparatively peaceful times the work of science is done in as high and noble a spirit as formerly is perhaps open to question.

The lesson which nearly all sensible men draw from the history of science is simply this, that the enlightened reason of man is the only interpreter of Nature's laws, and that physical theories handed down from remote antiquity have simply no claim whatever upon our acceptance in the present day. It matters not whether a misapplied ingenuity can find in them some distant resemblance to known facts, any more than it matters, when a weather prophet guesses at the weather, how near the mark or how wide of it his guess may fall. In the present day we have done with guessing in matters scientific. We may frame hypotheses, but, if so, their destination is to be confronted with facts; and if they can not abide the test we let them go. Some of our theological brethren are given to gloating over the mistakes made by scientific men, and point with triumph to the wrecks of scientific theory that lie along the highway of the world's thought. There is little justification for the triumph. No scientific theory ever perished except to give birth to a better. It would be nearly as sensible to take a man to some ancient cemetery and taunt him with the number of his dead ancestors. In humanity is the living germ which persists from age to age, though the generations of men fall like the shed leaves of the oak, and so with science: theories and systems may fail—though not till they have served their purpose—but science as a method, as a principle, as a power survives, and from generation to generation admits us into ever more intimate recesses of Nature's temple. Theology, too, it is sometimes said, is progressive, and, in a certain sense, doubtless it is. But in what does its progress chiefly consist if not in giving up a fruitless contest with science, and recognizing the perfect independence of the latter as an interpreter both of Nature and of man? If theologians are wise they will not only renounce forever the ancient conflict, but they will endeavor to make an ally of science and to impress upon it, to the utmost of their power, a moral aim. The business of science is not to deprive the world of religion, but rather to make religion possible for all men by removing the intellectual difficulties that have in the past more or less hindered its acceptance by enlightened minds. When the voice of authority is no longer raised to stifle intellectual inquiry, science will cease altogether to wear a negative aspect, and will gain universal recognition as the great constructor of whatever is sound in knowledge or of practical value in life; while religion will embrace the emotions and convictions that come to man from the contemplation of the all-comprehending universe and its Transcendent Cause.

INDIVIDUALITY FOR WOMAN.

As a general thing, when the importance of individuality has been insisted on, the individuality in view is that of man. It is he who has been exhorted to assert himself, to be true to his opinions, to live his own life; the exhortation has not been to any great extent addressed to his wife or his sisters. Enough for them if they can be so fortunate as to minister not unworthily to some grand male individuality. Women, however, though not particularly invited to the lecture, have been listening to it, and—what people do not always do with lectures or sermons—are applying it to themselves. The best of them are now aspiring also to be individuals. They want to think, to feel, to know, to do something as of themselves, and, if possible, to think clearly, to feel truly, to know surely, and to do efficiently. St. Paul said that a woman should not be suffered to teach: what would he say if he could attend an annual meeting of our National Educational Association, and see to what an extent woman has become the teacher of the youth of the nation? He said that if a woman wanted any information on doctrinal or religious matters she should go home and ask her husband. The husband of to-day knows more about business than he does of theology; and few wives, indeed, would think of consulting their husbands on the latter subject. In any case the conditions have totally changed since these dicta were uttered. Woman has access now to something wider than domestic teaching. The world of science and literature is open to her, and the need of depending solely upon her male relatives in intellectual matters is not very often felt. Among all the changes that mark our modern time we consider this one of the most important. The elevation of woman means the elevation of man. Many persons have distressed themselves over the thought of men and women competing for work, and doubtless such competition has already given rise to some unpleasant results. But, strictly speaking, competition *for* work is a feature of an imperfect social system, and therefore, as we may trust, an evil that is destined to disappear; while competition *in* work will remain as a powerful spring of progress. On the other hand, man will be roused by the rise of woman to a competition not so much with her as with himself. If he wishes to win her respect, to say nothing of conquering her love, he will have to be something better on the average than he has been in the past. Heretofore man has, consciously or unconsciously, counted too much on the power of instinct for his influence over woman; while she in turn has regarded him as a creature to be captivated mainly by appeals to the senses and by an appearance of subservience to his wishes. In the future the primitive attraction between man and woman will remain, but it will be so modified by intellectual and moral influences that it will not exercise the same mastery that it has done in the past, nor be so determining an influence in conjugal unions. It is vain to represent to women that it is their *duty* to marry; their first duty is to themselves, and only when marriage can give fuller scope to their individuality will the best women fo the now rising generation care to commit themselves to it. In some ways this may seem to bode evil, seeing that the less advanced will be as ready as ever to marry on the old terms; but, on the whole, we can not doubt that the reflex action on men will carry with it a large surplus of advantage to the world. We want *individual* men—that has long been recognized; but we want also *individual* women—that has only lately been recognized: when once woman becomes an individual in the truest and highest sense, civilization will have reached the threshold of its most glorious period.

LITERARY NOTICES.

Geological Survey of New Jersey. Annual Report of the State Geologist for the Year 1890. By John C. Smock. Trenton. Pp. 305, with Map.

Mr. Smock entered upon the office of State Geologist on the 1st of October, 1890. Previous to that time the clerical work of the office and the superintendence of the distribution of publications had been carried on since the death of Dr. Cook by Irving S. Upson, at New Brunswick. The present report includes work done under Mr. Upson and Mr. Smock. The office of the Survey has been removed to Trenton, but distribution is still attended to by Mr. Upson at New Brunswick. The work of the year includes studies by Mr. Frank L. Nason of the crystalline rocks of the Highlands and of the magnetic ores of that district. An interesting feature of his work is the discovery of fossils in those limestones which give a clew to their age and determine their relative horizon. They have been referred by Prof. Beecher, of Yale, to the Cambrian—below the Potsdam sandstone, the oldest fossiliferous horizon hitherto known in the State. Additional detailed surveys of the country of the crystalline rocks are necessary to an accurate knowledge of the relative position and true nature of the formations grouped as Archæan, and for their correct representation on the geological map. In the southern part of the State preparation has been made, with surveys by Mr. C. W. Coman, for a detailed geological map, showing the limits and areas of the various superficial formations of sands, gravels, clays, peats, tidal marshes, and other recent deposits. The area of the "Trenton gravel" has been ascertained and its limits determined, but its relation to the yellow gravels of south Jersey, and that of the brick-clays to the latter gravel, are yet to be made out. Observations for the volume on water-supply and water-power have been carried on under the immediate direction of Mr. C. C. Vermeule. The census of the water-powers—a new line of inquiry in the history of the survey work—is still in progress, and is, therefore, incomplete. Papers appear in the report on the artesian wells, particularly the recently bored ones in the southwestern coast-belts of the State. A report on the drainage-work inaugurated by the Survey and successfully carried on, is furnished by Mr. George W. Howell.

Geological Observations on the Volcanic Islands and Parts of South America visited during the Voyage of H. M. S. Beagle. By Charles Darwin, M. A., F. R. S. Third edition. With Maps and Illustrations. New York: D. Appleton & Co. Pp. 648. Price, $2.50.

Geological changes take place with such extreme slowness that a faithful account of the geology of any place written in Darwin's early life is nearly as accurate now as on the day it was published, and for the purposes of geological history even more valuable. That Darwin's observations are a faithful description of the localities that he visited, no one who knows the extreme thoroughness and conscientiousness of the man will think of questioning. Another fact that has operated to preserve the usefulness of these observations is that they relate to parts of the world that have not been so much studied as Europe and North America, so that the author was able to say in the preface to his second edition, "I am not aware that much could be corrected or added from observations subsequently made." Some of his opinions, however, have not stood the test of time so well as his facts, and were abandoned by Darwin himself in later life. The first half of the volume contains the descriptions of the volcanic islands visited by the Beagle, with a few observations made in Australia, New Zealand, and at the Cape of Good Hope. These islands include St. Jago in the Cape Verd group, Fernando de Noronha, Ascension, St. Helena, and the Galapagos Archipelago. There are several cuts in the text, and a folded map of the island of Ascension is inserted. An appendix comprises descriptions of fossil shells from several of the above-named islands, by G. B. Sowerby, and descriptions of corals from Tasmania, by W. Lonsdale.

The second division of the volume treats of the geology of South America, and almost exclusively of that part of the continent south of the Tropic of Capricorn.

The chapters, except in a few cases, are arranged according to the age of the deposits that they treat of. Considerable space is given to evidences of elevation of the eastern and western coasts of South America, while the formations of the pampas and the structure of the Cordillera are among the subjects of chapters. An appendix contains descriptions of Tertiary shells, by G. B. Sowerby, and of Secondary shells, by Prof. E. Forbes. Several folded plates illustrate the specimens described, and there is a map of southern South America.

The Relation of Labor to the Law of To-day. By Dr. Lujo Brentano. Translated from the German by Porter Sherman. New York: G. P. Putnam's Sons. Pp. 305. Price, $1.50.

This work was prepared by the author in answer to a request from his publishers for a new edition of his "Labor Guilds Past and Present." He thought that something a little different—a popular-scientific treatment of the labor question from the point of view of the labor-guilds—would be of greater interest. It is, according to the translator, "as to quantity of matter an abridgment, as to extent of ground covered, an enlargement" of the original work. The occasion for reproducing the book here is explained by the assumption that the classical political economy of England, prevalent also in this country, has been built up almost exclusively on the side of capital and the capitalist, and is full of theories and assumptions. Writers who have worked upon the structure have been mainly bankers, capitalists, or *doctrinaire* professors. "It is owing to a theory, an exploded theory, the wages-fund theory, that the relations of labor have not been scientifically discussed by our economists, and the treatment of the labor question has been left mainly to unscientific, more or less socialistic, even revolutionary, writers." As taught thus it discloses an antagonism between theory and practice, and is charged with furnishing ammunition to socialism. "Recognizing this antagonism, the political economists of Germany have set themselves to work to correct and to supplement, in this and other particulars, the classical, hypothetical, abstract political economy." Further than this, by a critical examination of the principles furnished by the English economists, upon which the socialists have built their superstructure, "the German economists have been able to modify, correct, and supplement them, and have thus undermined the theoretical foundations of socialism." Prof. Brentano has had exceptional facilities for the study of English trades-unions, having spent several years in the country, with free access to their records and archives; and he is master of the English language, and on familiar terms socially with English manufacturers and laborers. He also occupies (at Leipsic) one of the highest chairs of Political Economy in Europe. At the beginning of the present treatise he lays down, as the three principles which have in turn sought to govern the economic life of the ages, and struggled with each other for the mastery, those of authority, individualism, and socialism. Although each of these principles claims absolute correctness and exclusive control, no one of them has ever governed exclusively, nor has any one of them been entirely without effect. It is the task of science and of this book to investigate the relations, force, and operation of these principles in life. The conclusion of the whole is that the necessary key-note of our age, as of every epoch of grand progress, is individualism; but there are minors who need the protecting interference of the state, and for them the control of authority is still a necessity; but it must not be stretched beyond what is necessary. It must not be extended to those weak ones who, not isolated, but united, are able to guard their own interests. The fundamental principle of the economic order remains the free self-activity of individuals for themselves, and the free road necessary to the talented and the strong for the full development of their powers lies open to all. But the weak united arrive by it to independence, the minors acquire through it the necessary protection by means of legal barriers against abuses of economic superior power. "Wherefore this regulation of the labor relation contradicts the efforts of the feudal socialists who speak of the return of the old control of authority, in order by preventing the independence of the members of the lower classes the better to guard their own special interests. Wherefore, it contradicts further the demand of the social democrats to set aside all individual and social inequalities. But it corresponds with the ideals which have produced the great transformation of the entire social and political life since the end of the eighteenth century," and with the moral and political ideals of the age and with the fundamental principles of the law of to-day.

Achievements in Engineering. By L. F. Vernon-Harcourt. New York: Charles Scribner's Sons. Pp. 311, with Plates. Price, $1.75.

The author's purpose in this book has been to describe briefly some of the principal engineering works carried on during the last fifty years, in a style as free as possible from technical phraseology and intelligible to the general reader, at the same time introducing details and comparisons that will be interesting to engineers as well. A superabundance rather than a deficiency of material has been met, for the chief engineering triumphs have been accomplished during the last half-century, and the variety of adaptation has been almost endless. The author believes however, that an adequate variety of engineering works of great magnitude, difficulty, and importance have been described to justify the view that engineers, in directing the forces of Nature to the use and convenience of man, are among the greatest benefactors of mankind. American works are well represented, with descriptions of the New York elevated railways, railways across the Rocky Mountains and the Andes, the Detroit, Hudson, and Sarnia Tunnels, the St. Louis and Brooklyn Bridges, the operations at Hell Gate, the improvement works on the Mississippi, and the Panama and Nicaragua Canals, and many other American works are mentioned in illustration of principles. The list of works abroad described or referred to would be cumbrous to quote. In it all the classes we have mentioned are represented with the grandest achievements of foreign engineering. All together, however, are only a few remarkable instances chosen out of a great number of important works which engineers have carried on in almost every part of the world. It is impossible, the author adds, within a limited space, "to refer to various other branches of engineering science in which the skill of the engineer has conferred inestimable benefits on the human race. It has been shown how all the works facilitating locomotion on land, and affording access from the sea to ports, and by water-ways to the interior of a country, are due to the labors of engineers, and how the indispensable water-supplies for large towns are secured by their aid. Engineers, however, also provide for the drainage of large towns and districts, the mitigation of inundations on low-lying lands, the reclamation of lands from the sea, and the irrigation of large tracts of land in warm countries by which crops are preserved and famine averted, and they carry out the works for the illumination of streets and houses with gas and electricity. To their credit also are improvements in marine engines and increased speed of ocean steamers, and improvements in telegraphy and the laying of submarine cables, and if engineers in the future continue as in the last half-century, increasing and extending the benefits resulting from their works, they will justly be regarded as ranking among the greatest benefactors of mankind."

The Oyster: A Popular Summary of a Scientific Study. By William K. Brooks. Baltimore: the Johns Hopkins Press. Pp. 230, with Plates. Price, $1.

Prof. Brooks is our most thorough and successful student of the oyster. He has devoted a large part of his time to the study for more than ten years past, and, as President Gilman says in the introduction to this book, "he can hold his own not only among naturalists, but also among practical men. He has dredged in every part of the [Chesapeake] bay. To use his own words, he has tonged oysters in five different States; in the warm waters of the South he has spent months under the broiling sun, wading over the sharp shells which cut his feet like knives, studying the oysters 'at home.' He has planted them, he has reared them by collecting the floating spat, and he has hatched from artificially fertilized eggs more oysters than there are inhabitants of the United States." He has also studied the experience of other States and countries, and has gathered up the knowledge of the world in respect to the life of the oyster, "its enemies and its needs, its dangers and its protections." The results of this practical work and these studies are embodied in the present book in familiar style and language for the information of the public. The whole work—studies and book—has been prompted by the fact, which is printed in capital letters, that "the demand for Chesapeake oysters has outgrown the natural supply." Prof. Brooks's effort has been to find a way to increase and supplement that supply. For this, his essay offers many suggestions of value.

Popular Lectures and Addresses. By Sir William Thomson. Vol. III. Navigational Affairs. London and New York: Macmillan & Co. Pp. 503. Price, $2.

Volume third of this series of addresses precedes volume second in publication because considerable matter had been prepared on navigational subjects which were assigned to the third volume in the plan of the series, before any progress had been made with the geological lectures. The lectures included in this volume are one on Navigation, delivered to the Science Lecture Association; a British Association evening lecture on The Tides, with parts of a lecture before the Glasgow Association on the same subject; a British Association paper on the Influence of the Straits of Dover on the Tides of the British Channel and the North Sea, with appendixes on the tides of the southern hemisphere and the Mediterranean, and a sketch of a proposed plan of procedure in tidal observation and analysis, and on the equilibrium theory of the tides; and papers on Terrestrial Magnetism and the Mariner's Compass; Deep-sea Sounding by Pianoforte Wire; Lighthouse Characteristics; the forces concerned in the laying and lifting of deep-sea cables; and Ship Waves. To these is appended a concluding paper by Captain Creak, R. N., on the disturbance of ships' compasses by the proximity of magnetic rocks at considerable depth under water.

Natural Selection and Tropical Nature. By Alfred Russel Wallace. New edition, with Corrections and Additions. London and New York: Macmillan & Co. Pp. 492. Price, $1.75.

Many persons who have been interested by Mr. Wallace's Darwinism, and are not acquainted with his early works, will doubtless welcome this reprint of two volumes of his biological essays. These papers are popular enough to interest the general reader, while containing able discussions of important scientific problems. In preparing this edition two especially technical essays have been omitted, another has been divided and the parts relocated, and many corrections and some important additions have been made in various places. Two new papers have been added to the Tropical Nature and other Essays, namely, The Antiquity of Man in North America, and The Debt of Science to Darwinism. This division of the volume comprises also chapters on the animal life, vegetation, climate, and other features of the equatorial zone, tropical humming-birds, the colors of animals and sexual selection, the colors of plants and the color-sense, and the antiquity of man. Among the subjects of the essays on Natural Selection are the introduction of new species, protective resemblances, instinct, the philosophy of birds' nests, and natural selection applied to man.

The Electro-platers' Handbook. By G. E. Bonney Illustrated New York: D. Van Nostrand Co. Pp. 208. Price, $1.20.

The amateur who would like to possess table-ware, jewelry, or miscellaneous articles plated with silver or gold by his own hands, and the intelligent boy in a plater's shop who wants to supplement his oral instruction with a record of facts and figures that he can not well carry in his memory, will both find their needs supplied by this manual. Much or little electrical and mechanical knowledge may be used in electro-plating: the amateur may make his own battery or dynamo if he desires, or he may buy apparatus of one of the kinds and makes named in this book. The author tells just what kinds are suitable for doing plating, and why, and also describes the vessels, brushes, lathes, etc., required for the work. He next gives a chapter on preparing the work, which includes thorough cleaning and the grinding out of all scratches, pits, and roughness. The latter operation may be done very laboriously by hand, but the amateur will have it done in some shop on a lathe. The operation of "stripping" the remains of the old coating from articles that have been plated before, and the use of "dipping" and "quicking" solutions are also described here. Separate chapters are then devoted to electro-plating with silver, gold, nickel, copper, alloys, and with zinc, tin, iron, etc. All the little points that need attention are touched upon in each case, and in the chapter on silver full directions are given for burnishing the work. The directions are everywhere simple and concise, and the book is not burdened with historical matter, various alternative processes, or elementary science. The volume is amply illustrated, has a portrait of Faraday for a frontispiece, and has an index.

An Introduction to the Study of Mammals, Living and Extinct. By William Henry Flower, F. R. S., etc., and Richard Lydekker, F. Z. S., etc. New York: Macmillan & Co. Pp. 763. Price, $6.

This work is based largely upon the article Mammalia, together with forty shorter articles, written by the senior of the two authors for the ninth edition of the Encyclopædia Britannica. The article Ape, by Dr. St. G. Mivart, and several articles by Dr. G. E. Dobson and Mr. Oldfield Thomas, have also been used, with the permission of the writers. This material has been arranged, the gaps between the several parts have been filled, and new matter, especially on the extinct forms and the group *Artiodactyla*, has been added. Anatomy and classification are the subjects most largely treated, comparatively little attention being given to habits and mental traits. The text is illustrated with three hundred and fifty-seven figures, most of which appear in the Encylopædia articles above mentioned, while some have been drawn for the present volume, and some obtained from other sources. The well-known character of the Britannica is a sufficient index of the high quality of this work.

A Dictionary of Applied Chemistry. By T. E. Thorpe, F. R. S., assisted by Eminent Contributors. Vol. II. London and New York: Longmans, Green & Co. Price, $15.

The second volume of this important work goes from *Eau de Cologne* to *Nux Vomica*. Its most extended articles are those on Explosives, Fermentation, Gas (Coal, Oil, and Water), Glass, and Glycerin, on the metals Iron, Lead, and Mercury, and on India Rubber, Iodine, Matches, and Milk. The metallurgical articles treat extraction processes with considerable detail, and give many figures of the apparatus employed. Such manufactured products as glass, matches, and gas are treated with similar fullness. An example of the important articles that do not deal with technology is the one on Fermentation. In this article the difference between the organized and the unorganized ferments is first set forth. The organized ferments are then treated in the three groups, molds, saccharomycetes, and schizomycetes, and the ordinary methods of cultivation and study are briefly described. Next the various fermentations caused by each of these three groups are discussed, those induced by bacterial life being arranged in four subgroups, viz., fermentation by hydration, by decomposition, by reduction, and by oxidation. Putrefaction is also considered in this article, and the closing section deals with soluble ferments. The writer is Prof. Percy F. Frankland. Among the contributors of other important articles are Prof. P. P. Bedson (Lead), the late W. Lant Carpenter (Glycerin), W. H. Deering, of Woolwich (Explosives), J. J. Hammel (Fustic, Indigo, Lakes, Litmus, Madder, etc.), R. Warington (Artificial Manure, Nitrification), and Prof. W. P. Wynne (Ketones, Naphthalene). Among the chief articles which are unsigned and hence presumably by the editor are Ethyl Compounds, Fatty Acids, Fluorine, Lactic Acid, Manganese, Mercury, Milk, Milk-sugar, and Nitrogen. The names of its editor and contributors are a sufficient assurance that this dictionary will take high rank as a work of reference.

A History of Chemistry. By Ernst von Meyer, Ph. D. London and New York: Macmillan & Co. Pp. 556. Price, $4.50.

A large task has been thoroughly performed in this work. The history begins in the earliest times—before the birth of alchemy—and records the acquaintance of the Egyptians with metallurgy and with other technological chemical processes, and the theorizing of the Greek philosophers in regard to the elements of substances. It then traces the progress of alchemy from its earliest known manifestations in Egypt down to the eighteenth century. A chronicle of the iatro-chemical period follows, in which Paracelsus, Van Helmont, and De le Boë Sylvius were the leading spirits. The next chapter deals with the period of the phlogiston theory, from Boyle to Lavoisier, and the last division of the subject extends from the time of Lavoisier up to now. The knowledge of technological processes current in each period is set forth in these several chapters, and in the closing chapter the special history of each of the chief divisions of chemistry in the past hundred years is given. The plan of the work involves a statement of the attitude of each prominent chemist toward the science of his time and its problems, and an estimate of the effect and value of his work. This criticism has been continued even down to the investigators of recent years. A controlling purpose of the book is to describe the development of the general doctrines of chemistry from their earliest beginnings up to the present day, and thus to give a comprehensive survey of what is one of the most interesting panoramas in the history of science. The following extract illustrates the nature of the book:

> Dumas did not scruple to say plainly that the dualistic doctrine was harmful and retarded the development of organic chemistry, and he made every effort to set it aside and to replace it by the unitary theory. His attack upon Berzelius's doctrine (at that time held in high repute by most chemists) was vigorously answered both by the latter and by Liebig. Liebig indeed admitted many points which were disputed by Berzelius—e. g., the fact of substitution—but he protested against Dumas's wide extension of this principle (of substitution). The assertion of the latter that every element of a compound might be replaced by another, and yet the type be retained, was characterized by Liebig as entirely unproved, and met with an ironical rejoinder. Berzelius, who saw his whole system based upon the electro-chemical theory threatened, directed his criticism in the Jahresberichten for 1838 and the next five years or so against the theory of types.

Missouri Botanical Garden. Second Annual Report. By William Trelease. St. Louis: Published by the Board of Trustees. Pp. 117, with Plates and Plans.

The first volume of the reports of this institution, published in December, 1890, having been primarily intended to give an account of the establishment of the Garden and School of Botany, the present volume really begins the series of annual reports. The estate, including Shaw's Garden, is valued at $1,366,334. Much labor and money have been spent in putting the premises in repair. Efforts have been made to improve the garden in all respects, but particularly in those features which will make it attractive and instructive to visitors, and render possible in it the performance of substantial and useful botanical work. The task of mounting the Engelmann herbarium has been nearly completed, and the collection is temporarily deposited in a nearly fire-proof building, awaiting the erection of a permanent fire-proof house. Measures will then be taken to form a museum. The record is given of the school of horticulture, in which provision is made for six pupils at once, and the announcement of the Washington University School of Botany, to which the garden furnishes a laboratory and working-ground. Besides these accounts of routine work, the volume gives the proceedings at the first annual banquet to gardeners, florists, and nurserymen, given December 13, 1890, and, under the heading of "Scientific Papers," a revision of the American species of *Epilobium* occurring north of Mexico, by Mr. Trelease, which is richly illustrated.

The Soul of Man. An Investigation of the Facts of Physiological and Experimental Psychology. By Dr. Paul Carus. Chicago: Open Court Publishing Co., 1890. Pp. 458. Price, $3.

This work, containing one hundred and fifty-two illustrations and diagrams, chiefly of the nervous system in man and the lower animals, aims to present some account of The Philosophical Problem of Mind, The Rise of Organized Life, the basic facts of Brain Activity, some remarks upon The Immortality of the Race and the Data of Propagation, the results of some of The Investigations of Experimental Psychology, and The Ethical and Religious Aspects of Soul-life. According to Dr. Carus, the true conception of the soul is as form. The idea of form, he thinks, is not a mere speculative theory, but of practical importance, especially as related to the problem of life after death. The following passage will indicate the author's position on this point: "Man's soul was formed in the course of the evolution of the human race by the reactions upon the external influences of the surrounding world, and the present man is the outcome of the entire activity of his ancestors. . . . Every one of us began his life with the beginning of all life upon earth. We are the generation in which the huge billow of human life now culminates. We, ourselves, are that billow; our real self, our spiritual existence, will continue to progress in that great wave.

"Our existence after death will not merely be a dissolution into the All where all individual features of our spiritual existence are destroyed. Our existence after death will be a continuance of our individual spirituality, a continuance of our thoughts and ideals. As sure as the law of cause and effect is true, so sure is the continuance of soul-life even after the death of the individual, according to the law of the preservation of form" (p. 423).

The author regards "as not the least important feature of the book" its philosophical foundation as corroborating "the unitary conception of the world, commonly called Monism, or, more exactly expressed, Monistic Positivism."

A Clinical Study of Diseases of the Kidneys has been published by *Clifford Mitchell*, M. D. (Keener), in which the author insists on the importance of thorough examination of the urine for information in regard to not only diseases of the kidneys but also many other disorders, and in regard to the effects of diet and treatment. One hundred pages are devoted to the treatment of Bright's disease, including the regulation of diet, air, exercise, care of the skin, place of residence, psychical influences, etc. In writing this book the author has kept in view the needs of American patients, and has shunned those recommendations of English writers on diet and hygiene which are not suited to the climate of America. Although the title of the book limits it to renal diseases, the author has deemed it necessary, in connection with these, to pay attention also to those of the entire urinary tract.

Examen Quimico y Bacteriológico de las Aguas Potables is a treatise on drinking-water and its impurities by A. E. Salazar and C. Newman, of the laboratory of the Naval School at Valparaiso, Chili. It is the result of studies of the waters of the city carried on in the laboratory in 1887 and 1888, and is published partly as a guide to those who wish to make similar studies in other parts of the republic. Besides their own experiments, the authors, to qualify themselves for their work, visited the principal laboratories of Europe, including those of Dr. Miquel, of Montsouris; Dr. Ferran, of Barcelona; Prof. Emmerich, of Munich; Dr. Korralsky, of Vienna; Prof. Fodor, of Buda-Pest; and Dr. Fraenkel, of Berlin. The first part of the treatise relates to the examination for mineral constituents, including the determination of the weight of solids, of alkalinity, noxious metals, chlorine, nitric and nitrous acids, and gases; the second part, to the examination for organic impurities by the ammonia and permanganate processes; and the third part, to the bacteriological examination. To this is added a chapter on parasitical animals introduced by water into the organism, by Dr. Rafael Blanchard, of Paris. The work is illustrated by one hundred and twenty-seven engravings, sixteen photomicrographs, and five photograms of cultivations, and is published in London in Spanish by Burns & Oates.

Persifor Frazer's useful *Tables for the Determination of Minerals by Physical Properties ascertainable with the Aid of a Few Field Instruments* is published by the J. B. Lippincott Company in a third edition, entirely rewritten. The author's first intention was to introduce the method of determination pursued in the Royal Saxon Mining Academy at Freiberg, in a translation of Prof. Weisbach's tables; but he soon found that it would have to be modified in many particulars in order to meet the wants of American readers; and the changes and additions were so numerous as to make virtually a new book. The principle is insisted upon that every true mineral is a definite chemical compound or element, homogeneous throughout its parts, and capable of expression in a chemical molecular formula. This principle, which was at first opposed by Prof. Dana, has now been tacitly conceded by all modern writers, including Prof. Dana himself. The minerals are classified for purposes of identification into those of metallic luster, and then, subordinately, according to their colors; those of submetallic and non-metalic luster, and the color of their streak; and minerals of non-metallic luster with white or light gray streak, and according to their sectility or hardness. $2.

In *A Preliminary Report on the Geology of the Central Mineral Region of Texas*, which forms a part of the first Annual Report of the Geological Survey of the State, Mr. *Theodore B. Comstock* assumes that the region has never been adequately studied, and criticises the references to it by the geological writers who have spoken of it as betraying want of information. In his own report he gives only definite results which the facts known are fully believed to warrant. Of statements of previous authors which he summarizes a certain number have been verified by his observations, while as many more have been found incorrect; and, as a result of the field work of 1889, a considerable amount of new and wholly unexpected structure has been worked out.

Mr. *Ernest E. Thompson*, in his monograph on *The Birds of Manitoba* (United States National Museum), has made the political boundaries of the province the boundaries also of the district included, although it does not constitute a distinct zoölogical province. He spent altogether about three years in the province and in his studies of birds. He offers his observations as they were made on the spot, without condensation or generalization, believing that the only right course under the circumstances. His original plan was to prepare something "after a very old-fashioned model," but widening experience caused a change of view. His own observations are supplemented by those of numerous observers in different parts of the province, and citations of other scattered published matter. From his sketch of the physical features of the province, we learn that it is plentifully, almost too plentifully, supplied with water. Besides the numerous extensive lakes indicated on the map there are thousands more of smaller extent, while the region of the Red River Valley in particular is diversified by vast stretches of marsh and lagoon. The lakes consist of sweet or live-water lakes of various sizes, fed and drained by living streams and teeming with fish; and the alkaline lakes, which are mere drainage basins, and depend on evaporation for the removal of their accumulated waters. They owe their alkaline constituents to the continual influx and evaporation of surface water slightly impregnated with alkali, through running over the prairies strewn with the ashes of the annual fires. These "dead lakes" do not contain fish, but swarm with a species of *Amblystoma*, and leeches and aquatic insects, and are frequented by certain kinds of birds that seem to avoid the fresher waters.

In a paper on *Revised Astronomy* a contribution is made to theoretical astronomy from a new base by the Rev. *James W. Hanna.* After twenty years of study he has come to the conclusion that all the attractive forces of organic nature are one; that connected with it is another force, equally general and important, of repulsion; and that the resisting medium of space plays a larger part in the economy of the universe than it has been accredited with. Keeping these principles in view, he finds much in received astronomical theories to be corrected, and formulates his views in thirty-eight propositions. (Fleming H. Revell Co., Chicago and New York. Price, 35 cents.)

In an address on *The New School of Criminal Anthropology* delivered before the Anthropological Society of Washington by Dr. *Robert Fletcher*, the principal results of the labors of Prof. C. Lombroso, of Turin, are briefly presented, together with references to the works of other writers who are disposed to regard criminals as constituting to a greater or less extent a distinct class of the human race.

In the *Annual Report of the Chief Signal Officer of the Army for 1890* a decided improvement is noted in military signaling. During the year the heliograph was largely used in Arizona, nearly two thousand miles of military and sea-coast telegraph lines were operated, and considerable use was made of telephones. The meteorological work included the issuing of weather and temperature forecasts, the display of storm-signals, the gauging and reporting of rivers for navigation and flood-warnings, and the publication of weather maps, hurricane reports, the Weather Crop Bulletin, and the Monthly Weather Review. The percentages of successful forecasts were 84·4 for weather and 78·7 for temperature, giving a general average of 82·6. This is excellent in view of the statement made that "the average time at the disposal of the forecast official for the discussion and formal issue of weather forecasts is forty-nine minutes in the morning and fifteen minutes more at night," and that consequently "rarely can a minute be given to the predictions for any particular State or district." The accuracy of weather and temperature predictions had increased 1·7 per cent over the previous year; that of storm-signals had remained practically the same, 67·1 per cent. The details and statistics of the above and other work of the Signal Corps are given, with many maps, in special reports that occupy the greater part of the volume.

A *Report on the Cahaba Coal-field*, by *Joseph Squire*, has been issued by the Geological Survey of Alabama. This report describes the geology of the region, the chemical composition of the coals from different parts of the field, and the methods of mining employed there. Appended to the report is an account of the Geology of the Valley Regions adjacent to the Cahaba Field, by Eugene A. Smith, the State Geologist. The volume is illustrated, and is accompanied by a folded map.

Mr. *Arthur Winslow*, State Geologist of Missouri, reviewing, in his *Biennial Report of the Bureau of Geology and Mines*, the history of the geological survey of the State in past years, finds that "its life has been very fitful. It has existed for a few years, only to be discontinued before any plan of work was completed and at the sacrifice of much of the result reached. It has been weakened by successive changes of management with accompanying changes of policy. Its trained corps of employés and its equipment for work have been lost during the interim between two periods of activity; its collections, designed to illustrate the resources of the State, have been scattered, and with it all a considerable sum of money has been expended." The present management has spent a year in preparation, and is entering upon a systematic work. It is to be hoped that it will be left alone long enough to accomplish something of permanent value.

Parents who have never taken much thought as to what kind of schools their children go to should read *The Coming School*, by *Ellen E. Kenyon* (Cassell, 50 cents and $1). It is a companion to The Young Idea, by Miss Le Row, which reveals the sad absurdities that characterize the prevalent machine education, and supplements that book by pointing out the features that should be secured in the school of the future. The author's suggestions are illustrated by accounts of lessons actually given in some exceptionally fortunate schools of the present day. Among the chief changes urged by Miss Kenyon are that political boards of education shall give way to professional boards; that minute regulation shall be banished from the schools; and that the best teachers shall be assigned to the work of primary teaching, which is the foundation underlying all higher education.

The twenty-first "Summer Number" of *The School Journal* (New York) gives evidence of vigorous life in that publication. Its contents includes articles on a wide range of educational subjects, and the number is illustrated with portraits of prominent educators, plans of school buildings, and diagrams for drawing, writing, and other lessons.

The series of *Picturesque Geographical Readers* (Lee & Shepard, Boston) has been projected by Mr. *Charles F. King*, to make the learning of geography a source of pleasure as well as of real instruction. It aims to present the important facts of the science in a simple, interesting narrative style, so as to make the relation attractive. The books are intended to be used with the regular geography or atlas, and not in place of them; with the large and fuller maps of the text-books opened upon the pupils' desks, and the wall maps hung up, to be freely consulted as the lessons are read. It is advised also that the pupils be encouraged to write stories in connection with the pictures found in the book, to give oral abstracts of the lessons read, to name the pictures seen, to write the best single word to suggest the story in the chapter, and to draw and make as many of the illustrations as they can. The present volume is the second book of the series, and relates to this continent of ours. In it are given, in dialogue form, descriptions of the principal physical features of North America, including the frozen region, whaling, the land and water masses, the mountains, the Yellowstone Park and its geysers, central plain and eastern highlands, the rivers, climate and lakes, with special chapters on a few minor features; then an account on a similar plan of the Dominion of Canada; whence the reader is jumped, passing a special description of the United States, to like descriptions of Mexico and the West Indies.

A paper on the *Evolution of the Ordinance of 1787, with an Account of the Earlier Plans for the Government of the Northwest Territory* (G. P. Putnam's Sons), by *Jay A. Barrett*, is the first of a new academic series of papers, to be called the Seminary Series, which is started in connection with the Departments of History and Economics of the University of Nebraska. The institution of these series, in which historical, political, and economical questions are discussed in carefully studied monographs, is regarded in an editorial note as a sign that American universities are at last becoming centers of organized literary work. It affords a means also by which students may do useful work, make considerable additions to knowledge, and do the State a service. In the belief that a division of the labor is expedient, the Seminary Series, while not excluding other topics, will deal mainly with questions relating to Western history and economics. The *Evolution of the Ordinance of 1787* is a good beginning.

In a book on the *Origin, Purpose, and Destiny of Man*, of which Mr. *William Thornton*, of Boston, is the author and publisher, the doctrine is unfolded that all things are made up of three states, which are called the three ethers. Life is the first ether, which is a continuous aggregate. The second ether is a composition of the potentialities heat, light, electricity, and magnetism, mechanical power being manifested during the activity of these potentialities. The third ether is a material nucleus which permits of the action of the other two ethers. All bodies manifesting the second and third ethers independently of the first make up inorganic bodies. Organized bodies require all these ethers. These two conditions constitute all things natural and supernatural. The Creator is not to be found in the universe in any morphological form, but has only a subjective existence; and it is only when the subjective part of man exists as a distinct entity that he can ever know God.

Two novels of considerable merit, and

displaying much skill in construction and development, claim our attention. *What's bred in the Bone* (Benjamin R. Tucker, publisher, Boston) is a story of certain aspects of English social life by an author well known to our readers, *Grant Allen*. The story is told in a terse, vigorous style, without padding by expansion or episodes; the intricacies and complexities of the plot are tangled and untangled as by the hand of a master at the business; and an intense interest is wrought out. The name of the story seems to relate to a singular power of fascination which the heroine inherits from a gypsy ancestor, and to the persistency with which the gentle birth of the hero and his brother, made by circumstances friendless waifs on the surface of society, is declared in their acts and manners.

In *Juggernaut* (Fords, Howard & Hulbert) a chapter of American life and experience is handled with great power and truth to the reality by *George Cary Eggleston* and *Dolores Marbourg*. The Juggernaut is the idol ambition, or the car worldly success, under which an American starting as a young man with pure and noble intentions, and the purpose to maintain his character, is cast, with his wife, who has had simple and as pure beginnings, to be crushed. The story is one of the ruin of character that is so common in our financial and political life. The young editor, who has been honest and free, and is determined to continue so, is unwittingly drawn into the power of a schemer on whom he is for the time dependent, and is compelled to prostitute his paper for the furtherance of a single design of the other. He is determined to get the better of his master, and does it; becoming in his turn a speculator, financial operator, senator, and political schemer; making his wife, who was designed for the best things, his lobbyist, till she revolts at her fate, and ruin overtakes the pair. The story furnishes an instructive illustration of the fatal tendency of what are two conspicuous features of our national life.

A third story, by *J. Van Lennep*, translated from the French by Mrs. Clara Bell, *The Story of an Abduction in the Seventeenth Century*, is based on history. The foundation narrative is related in the fifth volume of Aitzema's Affairs of State and War, and concerns the carrying away from her friends by Johan Diederick de Mortaigne of a Dutch young lady, Catharine d'Orleans, and the pursuit of them, with divers political and diplomatic complications which the event evolved.

Our Language is the name of a modest journal of eight pages, devoted to preserving and improving the English speech, which is edited and published monthly by Mr. *Frederik A. Fernald* in this city (1778 Topping Street, fifty cents a year). The editor is an experienced journalist of literary taste and acquirements, and is an earnest advocate of a rational reform in spelling. That subject, the derivation and right use of words, and proper constructions are the chief topics discussed in its pages, and the spirit of the discussions is candid and catholic. Eccentric notions are not tolerated; and, while *Our Language* favors further reforms in spelling, it practically uses those changes only which have been agreed upon by all the reformers. The editor is in personal communication with the leaders in the reform movement, and enjoys their co-operation in his enterprise.

Science of Every-day Life and *Science applied to Work* (Cassell) are two convenient and useful treatises prepared by *John A. Bower*, the former for the Young People's and the other for the Artisan section of the National Home Reading Union. The chapters in Science of Every-day Life treat of some of the most common things, and the reasons for their existence: matter, weight, motion, air, combustion, and water; and furnish a few simple, rudimentary experiments. Science applied to Work is intended to be a useful introduction to the Science of Practical Mechanics, free from mathematical formulas, and to furnish hints for making mechanical experiments with simple contrivances. Both works aim to be clear and accurate in all their statements.

Having been, as an analytical and consulting chemist, frequently called upon to give information on the subject of water in its relations to disease, and having had much to do with the subject in connection with the Iowa State Board of Health, Dr. *Floyd Davis* has been happily prompted to prepare *An Elementary Handbook on Potable Water*, which is published by Silver, Burdett & Co.

In it are discussed the impurities in drinking-water that are oftenest the cause of disease and death, and the natural and artificial processes of removing them. The author's conclusions are the fruit of an experience gained in the analysis and study of nearly a thousand water-supplies, and are aided and re-enforced by the studies and writings of others. A definition of pure water, in a potable rather than a chemical sense, is sought in the first chapter. The inorganic, the vegetable, and the animal constituents of water, micro-organisms, water-supplies, natural and artificial purification, and central filtration, are considered in the several succeeding chapters. Of analysis, only a few elementary qualitative tests are mentioned, the general subject being reserved for another book, which is announced. The language is such as can be easily understood by every intelligent person.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Bulletins and Reports. Cornell University. Farm Manures. Pp. 12.—Forcing of Tomatoes. Pp. 20.—Georgia. Crop report for June, 1891. Pp. 14.—Massachusetts. Analyses of Chemical Fertilizers. Pp. 40.—New York (Geneva). Report of the Board of Control for 1890. Pp. 458.—Ohio. Insects. Pp. 16.—Utah. Seeds and Tillage Tools. Pp. 14.—Wyoming. Organization and Proposed Work. Pp. 24.

Astronomical Society of the Pacific. Publications. Vol. III, Nos. 14 and 15. Pp 153. San Francisco.

Bigelow, Prof. F. H. The Photochronograph and its Application to Star Transits. Georgetown, D. C., College Observatory. Pp. 36, with Plates.

Blair, Andrew Alexander. The Chemical Analysis of Iron. J. B. Lippincott Co. Pp. 314. $4.

Call. Prof. H. Ellsworth, Des Moines, Iowa. The Cost of a Geological Survey of Iowa. Pp. 4.—On a New Serpent from Iowa. Pp. 3.

Cooper Union. Thirty-second Annual Report of the Trustees. Pp. 78.

Dyer, Louis. Studies of the Gods of Greece at Certain Sanctuaries recently excavated. Macmillan & Co. Pp. 457. $2.50.

Ethics, Applied, School of. Summer Sessions. Plymouth, Mass. Pp. 24.

Foshay, P. Max. Preglacial Drainage and Recent Geological History of Western Pennsylvania. Pp. 7.—Do. and Richard R. Hice. Glacial Grooves at the Southern Margin of the Drift. Rochester, N. Y.: Geological Society of America. Pp. 7.

Foster, Michael. A Text-book of Physiology. Fifth edition, revised, Part I. Macmillan & Co. Pp. 220.

Gutekunst, Philadelphia. Photograph of Joseph Leidy.

Hale, Horatio. Was America peopled from Polynesia? Pp. 16.—(Do., Editor) Sixth Report (British Association) on the Northwestern Tribes of Canada. Pp 161.

Halsted, Byron D., New Brunswick, N. J. The Migration of Weeds. Pp. 8.

Heath, D. C., & Co., Boston. Catalogue of Publications. Pp. 160.

Hemstreet, William. Mind is Matter. The Substance of the Soul. Fowler & Wells Co. Pp. 252. $1.

Hill, Robert T., Washington. The Comanche Series of the Texas-Arkansas Basin. Pp. 26.—Notes on the Geology of the Southwest. Pp. 8.

Hinton, Richard J. Progress Report on Irrigation in the United States. Government Printing-Office. Pp. 337.

Holyoake, George Jacob. Life and Career of Charles Bradlaugh. Buffalo: H. L. Green. Pp 16. 15 cts.

Hornaday, William T. Taxidermy and Zoölogical Collecting. Charles Scribner's Sons. Pp. 362. $2.50.

Hutchinson, Waldo. The Vis Medicatrix. Vol. I. No. 1. Monthly. Des Moines, Iowa. Pp. 55. 20 cts., $1 a year.

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POPULAR MISCELLANY.

Exploration of Mount St. Elias.—The Mount St. Elias expedition organized by the National Geographic Society, under the leadership of Mr. I. C. Russell, with Mr. Mark B. Kerr as topographer, left Seattle, Washington, in June, 1890, and after spending more than two months on the mountain-sides, one half of that time above the snow-line, returned with notes, specimens, and data of the greatest interest. The topography was sketched over an area of about one thousand square miles, and includes the determination of the geographical position and elevation of Mount St. Elias and many neighboring peaks. Mount St. Elias is indicated to be not so high by some four thousand feet as the heretofore accepted elevation, nineteen thousand five hundred feet. The difficulties attending the determination of the height of this mountain are so great that the range between the extreme elevations that have been given by different explorers is nearly six thousand feet. Vice-President Ogden, of the National Geographic Society, suggests that as this is believed to be the first height for the mountain that has been derived from a carefully measured base, it is entitled to much weight. But the difficulties in suitably placing the triangles of measurement were so great that even the new elevation must be accepted with caution till it is verified. Although the party were prevented by storms from reaching the summit of Mount St. Elias, Mr. Russell is confident that he has found a practicable route.

A Glacial Monument.—One of the most interesting objects of the excursions of the Cleveland meeting of the American Association of 1888 was the group of wonderful glacial grooves on the limestone of Kelley's Island, Lake Erie—probably the most remarkable specimen of the kind in the world. The rock was being rapidly quarried away, and the pleasure felt at the sight of so rare a specimen of glacial action was marred by the apprehension that it would soon all disappear, a sacrifice to the commercial spirit of the age. A pledge was given at the time by the President of the Kelley's Island Lime and Transport Company, owning the quarry, that the most interesting grooves should be preserved. This pledge has now been fulfilled. The company at its last annual meeting voted to deed to President M. C. Youngblood a strip of land fifty feet wide and a hundred feet long, as surveyed by Prof. G. F. Wright and the Rev. Dr. Sprecher, containing the groove, to be deeded by him to some scientific or historical society, to be preserved in perpetuity for the benefit of science. It is to be presented to the Western Reserve Historical Society of Cleveland. The portion of the groove preserved is thirty-three feet across, and is cut in the rock to the depth of seventeen feet below the line extending from rim to rim. The groove is not simple, but presents a series of corrugations merging into one another by beautiful curves. When exposed for a considerable length, it will resemble nothing else so much as a collection of prostrate Corinthian columns lying side by side on a concave surface. Quarrying has proceeded nearly all around the specimen, "and soon the monument preserved will be a monument indeed," the groove being left to cap a pedestal about thirty feet high, and conspicuous from every side. About one half of the surface will be cleared of *débris*, so as to show fifty feet of the length of the groove, while the other half will remain as it is, beneath the protective covering of gravel, sand, and mud.

Characteristics of Aboriginal American Poetry.—The characteristic feature of the aboriginal poetry of America is defined by Prof. Brinton, in his presidential address to the Numismatic and Antiquarian Society of Philadelphia, as repetition. "The same verse may be repeated over and over again; or the wording of the verses may be changed, but each may be accompanied by a burden of refrain which is repeated by the singer or the chorus. These are the two fundamental characteristics of aboriginal poetry, which are found everywhere on the American continent. The refrain is usually interjectional and wholly meaningless; and the verses are often repeated without alteration, four or five times over. These were the simple resources of the native bards. They had one other. In every American language which I have examined for this purpose I have found the existence of a poetic dialect, of a form of speech markedly distinct from that of ordinary life, a phraseology consecrated to the inspiration of the divine afflatus; as the noble old poet, Spenser, expressed it, 'a ladder of the gods.' In this, and in this alone, did the native poets pour out their wild chants. These, I say, were their simple resources. Do not look upon them with contempt. At no time has poetry felt that it could dispense with them"; and the author draws illustrations of the fact from Poe, Tennyson, and Clarence Mangan. A great many of these American songs "are wholly without intelligible meaning; both verse and refrain are merely interjectional; they are sound and fury, signifying nothing. Such are the war-songs of the Iroquois and many others which I could name. But in defense of these I would ask you to remember that they are *sung*, not written to be read, and they must be judged by the laws of vocal music. . . . These broken syllables, these choked utterances, these inarticulate cries are the emotional outbursts of sentiment and passion, the oldest, the most heartfelt, the most untutored language of human feeling, the spontaneous revelations of that common nature which makes the whole world kin."

The Salt Marsh of the Kavir.—Lieutenant H. B. Vaughan, who made a journey of 1,164 miles in eastern Persia, thus describes one of the most curious features of the country, the salt swamp of the Kavir: "As we quitted the defile, a sudden turn in the road presented to our astonished gaze what at first sight looked like a vast frozen sea, stretching away to the right as far as the eye could reach in one vast glistening expanse. A more careful examination proved it to be nothing more than salt formed into one immense sheet of dazzling brilliancy, while here and there upon its surface, pools of water, showing up in the most intense blue, were visible. Away to the north of it stood a distant row of low red hills. A peculiar haze, perhaps caused by evaporation, hangs over the whole scene, which, though softening the features of the distant hills, does not obliterate their details. This, which I now see before me, is the great salt swamp, to the presence of which the Dasht-i-Kavir owes its name. This swamp, lying at a low level in the center of the great desert, receives into its bed the drainage from an immense tract of territory. All the rivers flowing into it are more or less salt, and carry down to it annually a great volume of water. The fierce heat of the desert during the summer months causes a rapid evaporation, the result being that the salt constantly increases in proportion to the water, until at last the ground becomes caked with it. The Persians say that many years ago a sea rolled its waves over the whole of the depression where I am now traveling, and that it was navigated by ships which used to sail from Semnan to Kashan. My guide told me the following legend: 'One day, many years ago, long before the time of the Prophet, a holy man arrived at Kashan, took a boat, and ordered the man to sail him across to some point or other. The boatman, being of a suspicious turn of mind, insisted on payment of the fare before landing. This condition was accepted, but the amount offered was held insufficient, and a *pour boire* was demanded in addition. After a dispute the point was yielded, and the old man said nothing more until he reached the shore, when, taking up a handful of earth from the ground, he threw it into the sea, uttering the words, "Avaricious boatmen shall here ply their trade no more." The sea instantly disappeared, and in its place came the desert as it now stands; while the fish became turned into stones, the boatman who tried to swindle was struck with blindness, and the holy man went on his way rejoicing.' I suggested to my guide that this was rather a severe punishment for so small a fault, and that an earthquake or a severe storm which would have sent all the boatmen to the bottom of the sea might have been sufficient to meet all the requirements of the case. He said he didn't know about that; anyhow, this was the story as he had heard it recounted by his tribe, who had lived on the borders of the desert for ages."

The Leaves of the Tulip Tree.—In the examination of some young plants of the tulip tree (*Liriodendron tulipifera*), Mr. Theodor Holm observed that, though their germination did not present anything of particular interest, a peculiar feature appeared in their young foliage leaves. The two or three leaves showed a great similarity among themselves, and at the same time differed from those of the older or full-grown tree. Induced by this discovery to examine the foliage of the mature tree, he found that there was a certain regularity of variation, depending upon the position of the different forms of leaves. It is well known that a great variation exists among the leaves of our recent *Liriodendron*, on the same tree, and even on the same branch. There are also great differences in the forms of the leaves of fossil species, which many palæobotanists, including Prof. Newberry, regard as being significant of specific distinctions. Mr. Holm believes, and undertakes to show in his paper, that the differences in the foliage between many of the extinct species of *Liriodendron* are not greater than between a series of leaves from a very young tree or from a branch of an older one of our recent species.

Navajo Burials.—Four methods of disposing of the dead are described by Dr. R. W. Shufeldt as practiced by the Navajo Indians. The commonest method is "cliff-burial," in which the body is removed from the lodge or *hogan* where the death took place, and is carried to a cañon, deposited in some of the rents or fissures in its sides, and is covered and walled in with pieces of rock and smaller stones. The body is often dressed in the clothes that the person may have possessed and valued during life. A second method is "brush-burial," and is resorted to in cases where illness has been long and no hope of recovery is entertained. The patient is carried to some secluded spot near the camp, surrounded with brush-cuttings as a protection against wild animals, and is either abandoned or fed from time to time by relatives until death comes. A third method is deposition in a grave; and the fourth is "tree-burial." This is extremely rare, so that only one case has come under the author's observation. The body was wrapped in a blanket and carried up into a large piñon tree to a horizontal limb about fifteen feet above the ground. At that point a rude platform had been constructed of dead and broken limbs, the whole so arranged as to support the body firmly in a horizontal position. The burials are all without ceremonies. The *hogan* is abandoned or burned immediately after the occurrence of a death within it, and is not in any event occupied by any of the tribe again. The Navajos have a notion that the devil long haunts the locality where death has taken place, and they all shun it. After a burial the party thoroughly wash themselves and make a complete change of clothing. They believe that an evil spirit is at the bottom of everything that has to do with death, and rarely speak of their dead for fear of offending him; and it has been said that one of these Indians will freeze to death rather than build a fire for himself out of the logs of a *hogan* in which one of their number has died. They are very jealous of any desecration of their dead; and Dr. Shufeldt was exposed to much danger in trying to get some of their skulls for scientific purposes.

Dances of the Passamaquoddy Indians.—In the snake dance of the Passamaquoddy Indians, as described by J. Walter Fewkes, in his paper on the folk lore of the tribe, the leader or singer begins by moving about the room in a stooping posture, shaking in his hand a rattle made of horn, beating the ground with one foot. He peers into every corner of the room, either seeking the snake or inciting the onlookers to take part, meanwhile singing the first part of the song. Then he goes to the middle of the room, and, calling out one after another of the auditors, seizes his hands. The two participants dance round the room together. Then another person grasps the hands of the first, and others join, until there is a continuous line of men and women, alternate members of the chain facing in opposite directions, and all grasping each other's hands. The chain then coils back and forth and round the room, and at last forms a closely pressed spiral, tightly coiled together, with the leader in the middle. At first the dancers have their bodies bent over in a stooping attitude, but, as the dance goes on and the excitement increases, they rise to an erect posture, especially as near the end they coil around the leader with the horn rattles, who is concealed from sight by the dancers. They call on the spectators to follow them, with loud calls mingled with the music; these cries now become louder and more boisterous, and the coil rapidly unwinds, moving more and more quickly, until some one of the dancers, being unable to keep up, slips and falls; then the chain is broken, and all with loud shouts, often dripping with perspiration, return to their seats. The last part of this dance resembles a play among boys known as "snap the whip." This dance is performed at weddings and other festive occasions, and is said to derive its name from the sinuous course of the dancers. In the trade dance the participants, one or more in number, go to the wigwam of another person, and when near the entrance sing a song. The leader then enters, and, dancing about, sings a continuation of the song he sang at the door of the hut. He then points out some object in the room which he wants to buy, and offers a price for it. The owner is obliged to sell the object pointed out, or to barter something of equal value. Passamaquoddy Indians are believers in a power by which a song sung in one place can be heard in another many miles away. This power is thought to be due to *m'toulin*, or magic, which plays an important part in their belief. The folk stories of the Passamaquoddies are but little known to the boys and girls of the tribe. It is mostly from the old and middle-aged persons that these stories can be obtained. The author was told by one of these story-tellers that it was customary, when he was a boy, to reward them for collecting wood, or for performing other duties, with stories.

What constitutes a Filth Disease?—Summing up, in the Sanitarian, his observations in answer to the question, "What constitutes a filth disease?" Dr. S. W. Abbott concludes that a filth disease is one in relation to which filth in some form or other, either wet or dry, plays the part of an important factor only in its causation, but is not itself the direct cause; that it acts either as a favorable soil for the propagation of disease germs (other favorable conditions also existing), or as a suitable medium or vehicle for the transmission of the particular contagium from the sick to the well. The filth which promotes the spread of infectious diseases is specific filth, and the importance of removing all filth lies in the fact that thereby we are sure to remove the specific filth, or that which contains the germs of infectious disease. The point to be emphasized is, that when filth is removed it should be done with the principle in view that filth is a condition rather than a cause, that it is the soil for the culture and transmission of infection, and not the infection itself; and that, just so far as the principle of infection is deprived of its proper soil, so far is one of the most important conditions of its growth and propagation removed. In sanitation, careful watching and provision against the introduction of infectious disease, isolation of the sick, disinfection of houses, clothing, and other associated material are as essential as the removal of dirt.

The Special Talent to be cultivated.—The Workingman's School of the United Relief Works of the Society for Ethical Culture was founded in 1878, to be a free Kindergarten for the children of the poorer classes in the tenement-house district of the city. It has now between three hundred and four hundred pupils, with three grammar, three primary, and three Kindergarten classes, and owns a substantial five-story building for its class-rooms and shops. Besides the ordinary branches, its course of study embraces manual and art work, elementary natural science, gymnastics, and music, etc., and a Kindergarten normal department. After two years it was decided to attempt the development of the Kindergarten principle, "learning by doing," in such a way that it might become the basis for a complete course of study in a regular school covering the ages from the sixth to the fourteenth year. The school is not a trade school, nor is it adapted only to the needs of a particular class. It aims to give its pupils, be they rich or poor, an education calculated to bring all their faculties into harmonious play. The chief merit of the manual work is its educational value. Trades are not taught, but shopwork, modeling, needlework, etc., have been introduced as so many aids to cultivation and development of every kind. And thus, says the report, "we believe that one of the worst evils of conventional 'schooling' has been done away with. For our experience has clearly shown, that the standard of education, heretofore universally accepted, which makes the literary progress of a pupil the principal test of his mental capacity, is altogether false. Literary ability is a special talent, as much as is proficiency in music or in any of the fine arts. And as there are many persons who have not the slightest gift in these directions, so are there many who can not write a pleasing essay or letter, or appreciate the style of a great author; yet the unmusical man may be a clever and successful business man, and the non-literate man may become a great artist or develop genius in some other direction. In fact, many a man who in his boyhood found it difficult to adapt himself to the literary standard of the school has broken his way to fame and success by means of talents of which his pedantic teachers had not the faintest inkling. . . . In our school we have had and yet have pupils who seem to be still incapable of acquiring the art of composition or even the lesser grace of correct orthography. Some of these have been with us only a short time, and we are therefore not responsible for their deficiencies; but some have been pupils of the school from the Kindergarten up, and have received the same careful training as the others, yet they lag behind in language. Nevertheless, some of these non-literate pupils do admirable work in other branches. It has been noticed that in the case of these children proficiency in manual training and art work, and in natural history, usually go together. They exhibit the liveliest interest in these branches, and their inner life appears to be rich, while their faculty of expression is only a stammering. With such pupils the greatest patience must be exercised. After they have developed their peculiar bent, and are encouraged by their success in the manual branches, they gradually gain ~ better control of tongue and pen."

Systematic Begging.—The business of begging is better organized in Paris than in American cities. A large association exists there, calling itself the Paris Syndicate of Professional Mendicants. The managing committee assigns posts to its members, protects them from competition, collects their receipts once or twice a day, and pays each one his proportion of the general profits once a week. The proper income of each post is accurately known, and any "embezzlement" is quickly detected and punished. A certain percentage of the receipts is retained for the general expenses of the syndicate and for a reserve fund. A lodging-house has been bought with this fund, and the remainder is invested in shares and bonds. There is no sick or burial fund—the sick are best able to excite charity, and when they become actually disabled there are the free hospitals; while the funerals of the poor are paid for by the state. Why should the professional mendicants waste their money on these things, when the tax-payers will provide them? The alleys in the Champs-Élysées are good posts for picturesque-looking old men. On a good day such should collect from thirty to forty francs each—six to eight dollars. One veteran used to get as his share of the division over seventeen dollars a week. He has now retired. The better class of mendicants look forward to saving enough to buy a cottage in the country, and living thereafter on an annuity, while the good-for-nothings spend their income in sottish debauchery. The Municipal Council, after an investigation, recently decided to tolerate the existence of the syndicate.

The Soaring Puzzle.—Marey, the author of Animal Mechanism, has recently published a book on The Flight of Birds, in which he gives an answer to the much-debated question as to how birds soar. Many persons have wondered at the power possessed by birds—especially the large birds of prey—of moving against a breeze without a flap of their wings. This has been regarded as like a log thrown into a river floating against the stream. Birds when soaring fly in circles or ellipses, which appear to observers below to lie in horizontal planes. But Bakounine discovered that these ellipses were inclined—the forward end being the lower. Taking this with the fact that a head-wind is a necessary condition, M. Marey concludes that each strong gust of wind, striking the bird's wings at an angle, raises it and wafts it backward, until the wind lessening somewhat permits the bird, by changing the slant of its wings slightly, to glide forward and downward with the force due to its elevated position. One side of an ellipse is described as the bird is carried upward and backward, the other as it advances and descends. This theory makes the circling and soaring depend on variations in the force of the wind. But even when the breeze is steady birds seem to have the power of modifying its action by shifting the angle at which their wings are presented to it.

United States Division of Forestry.—Chief-of-division B. E. Fernow, in his report on Forestry, gives as the chief object of the establishment of the division the prospective danger to the future of wood-supplies arising from the heavy drains to which our virgin forests are subjected without any provision for recuperation or reforestation; the destructive nature of the measures now used for utilizing the natural forest areas; and the desirability, for the sake of climatic amelioration, of encouraging tree-growth on the treeless areas of the West and on regions of the East that have been made treeless. The capacity of yield of our present wooded area is estimated to be only half of the present computed consumption. In addition to the estimates we have reports from various manufacturers noticing the decline of supplies of particular kinds. It is thus obvious that the present rate of consumption is greatly in excess of the supply. The effect of unwise denudation upon soil, water-flow, and climatic conditions has been made a continued study, in the light of experiments and experiences in other countries rather than in our own. The results of Prof. Harrington's investigations into the literature of the subject are to be published. There are three methods open by which the Government can promote a change in present forest conditions: by placing its own timber holdings under rational treatment; by direct aid to those who would apply forestry principles in caring for the natural woodlands or in creating new forest areas; and by supplying information. The effort to promote timber-culture by offering free entries of land for planting one sixteenth of it in trees has not been successful. *Bona fide* settlers have failed, through unfavorable climatic conditions and ignorance of method and of plant material suited to the localities, to obtain the required stand of trees. A modification of the law, rather than its repeal, is suggested. Information has been supplied by the division in circulars, bulletins, addresses, papers, and informal talks to associations and meetings. Among the publications were circulars giving instructions for the growing of seedlings and for the treatment of seedlings in the nursery. The most important publication was one on the substitution of metal for wood in railroad ties. A check list of our forest trees is in preparation as a means in securing uniformity in nomenclature; and an examination is planned of our prominent timbers in regard to their technical and physical properties in order to ascertain, if possible, how far these properties depend upon the conditions under which the trees are grown, how far physical properties influence mechanical properties, and whether a simple method can not be devised of determining the quality of timber by gross examination of structure.

Forest in Hungary.—Of the 9,200,000 hectares (about 22,000,000 acres) of forest in Hungary, the Government owns about 1,500,000 hectares (or 3,500,000 acres), while the rest belongs to public bodies and private persons. The Government does not sell any part of its forests, but buys more each year. In some parts of the country, as in the eastern region of the Carpathians, woods are found of several thousand acres in extent, consisting for the most part of red beech. This is used for fire-wood, carriages, staves, and agricultural implements, and in the manufacture of bent wood. There are few fires, and they seldom permanently damage the woods. There are large resinous forests in Transylvania, but they are not very accessible; and there are also some in the district of Marmaros, in the northeast of the country.

International Selfishness. — The tidal wave of high tariffs that seems to be passing around the globe at the present time reveals an attitude of many peoples toward neighboring countries which is little better than that existing between communities during the most quarrelsome ages of history. The advocates of restrictive tariffs are not only zealous to increase sales for their own people, but positively exult when they reduce those of foreigners. And, when one nation has injured another in this way, that other is now very likely to strike back by means of "retaliatory legislation." Americans and Europeans have sunk to the morality of the Chinese, who regard the sufferings of all but themselves with amusement and pride, and any one who talks of neighborliness and consideration for other nations is set down as too sentimental to meddle with practical affairs. Strange to say, the fact that foreign workmen are in want and misery has been urged as a reason for trying to injure them further. Even the socialists, who proclaim the brotherhood and equal rights of man, are very apt to limit these principles by geographical boundaries. But the further a pendulum swings from the upright position, the sooner its return may be expected. Hence it is quite likely that a new era is soon to dawn, in which humanity shall no longer be dominated by geography.

Dry Denudation.—Dry denudation is shown by Prof. Johannes Walther, in his book on Denudation in the Desert, to be a process of considerable geological importance. The author points out that no part of the African desert is absolutely rainless, and that, as the storms, though rare, are heavy, the mechanical effects of water are more marked than they would be in a region where precipitation was more uniform. But in a desert, where the absence of plants and of soil exposes the rock to the effects of atmospheric variations, changes of temperature are yet more potent in causing denudation. These changes, owing to the dryness of the air, are very great. The diurnal range may be 30° C., and the annual range as much as 70° C. By the constant expansion and contraction due to these variations, the rocks are split, and the results are more important in producing denudation than are chemical changes. Illustrations are given to show how rock-masses in the desert are destroyed by heat and cold, wind, and drifting sand. The surfaces of old walls are corroded; strata of different hardness in the face of a cliff are worn back unequally; masses of rock are isolated, and the blocks and pillars are carved into strange forms; denudation, in short, seems to proceed as actively in a desert as in a damp climate, and along very much the same lines. Isolated hills of tabular form are also characteristic of desert denudation. Such hills may be either on a large scale—outlines of an extensive plateau—or on a small one, like models, but a few feet high. In each case the cause is the same: a harder stratum at the top has preserved the softer material below. The author also describes the valleys of the desert, usually dry, and the cirques which, as was pointed out some years since by Mr. Jukes Browne, seem to occur in the deserts of Egypt even as in regions where ice may be supposed to have acted. "The description of the latter forms is important," writes T. G. B. in Nature, "since it indicates that there is not that necessary connection between glaciers and cirques which some geologists seem to have imagined."

The Teacher's True Power.—The extreme elaboration of system in school, says State Superintendent Sabin, of Iowa, gives us symmetry and uniformity, but it is at the expense of growth. It promotes smoothness, prevents friction, and furthers exactness of detail, but it crushes out all life, energy, freshness, and enthusiasm, and exalts itself to the chief place in the school. The child is forgotten in the worship and homage which is paid to the system. We sometimes speak of teaching the child to think. It is as natural for a child to think as it is for a tree to grow. It is not the part of the teacher to wake up the mind, but to avoid putting it to sleep. Give the child the same freedom to think and observe that the street Arab has in his games, only guide him with skill; take advantage of his curiosity and wonder; take advantage also of what he already knows, and do not attempt to teach over again what he has already learned, and he will startle you by his progress, and by the readiness with which he will profit under your instruction. There is no place in which the individuality of the teacher can so make itself felt, and in which the individuality of the child is so thoroughly alive, as in the primary room. The author does not object to the rigid examination in the case of young teachers; but, when that is once passed, the only conditions imposed upon the teacher should be enthusiasm, life, growth. When these are absent, the teacher is dead. Knowledge, to be of any value to the teacher, must become a permanent, increasing, living force in his work and character. Knowledge which is non-productive is dead. Knowledge which is alive, which strengthens the memory, which guides the judgment, which enlightens the reason, which fortifies the will—this is the knowledge which, acting through his individuality, makes the teacher a power in the school.

Hand-marks.—M. Bertillon, of the Paris police, has devised a method of identification by photography of parts of human bodies. The hand being the part that is usually most affected by the occupation, series of photographs of hands have been taken, which may be compared with whole figures of the same workmen at their work. They show the effect upon the organ of friction from tools in use. From the hands of the navvy all the secondary lines disappear, and a peculiar callosity is developed at the spot rubbed by the spade-handle. The hands of tin-plate workers are covered with little crevasses produced by the acids employed. The hands of lace-makers are smooth, but they have blisters full of serum on the back and callosities on the front part of the shoulder, due to the friction of the straps of the loom. The thumb and the first joints of the index-finger of metal-workers show large blisters, while the left hand has scars made by the sharp fragments of steel.

Tea-culture.—According to a Society of Arts lecture by Richard Bannister, tea is derived from the cultivation of two species of tea plants, the Chinese and the Assamese. Hybrids of various degrees between these two form a great proportion of the plants usually grown. In the tea-garden the plant is kept down to from three to six feet in height; in a state of nature it reaches thirty or forty feet, with a stem one foot in diameter. The seed, which is inclosed in a hard, round shell, ripens about one year after the flower has faded. Planting is done either direct from the seed itself, or from nurseries where the young plants can be watched carefully and tended till they are strong enough to take their places in the plantation. Tea grows on almost all soils, but one that is light, friable, and rich is necessary for complete success. Close planting is recommended—viz., four feet apart—equivalent to 2,722 shrubs per acre. On steep slopes the Chinese variety may be planted closer—two feet by three and a half feet, or 6,223 plants per acre. A good deal of care must be devoted to pruning, with the object of keeping the shrub well spread and at a convenient height for picking. A tea plant is picked as the successive "flushes" occur. A flush is the throwing out of new shoots and leaves, the latter of which form the tea of commerce. The average flushing period is from seven to nine months, and the intervals between flushes vary from seven to fourteen days. The number of flushes ranges from eighteen, where no manure is used, to twenty-five in good soil. To a certain extent, the harder a tea plant is picked, the more it becomes stimulated to reproduce new shoots in the place of those lost. When the season is over, the tea bush is from three and a half to four feet in height and about five feet in diameter; pruning down, its height is reduced to two feet and its diameter to three feet. In this state it remains during hibernation. In the spring the buds at the base of the leaves develop into shoots, the buds of which develop themselves in the same way. The first shoot from the branch becomes the nucleus of subsequent flushes on that part of the bush, and is therefore carefully preserved. The youngest leaves give the best tea.

Making Incandescent Lamps.—An incandescent or glow lamp consists, according to Major-General Webber, from the manufacturing point of view, of the filament, the wire mount, or conductor, and the glass bulb. Inventors, seeking a highly refractory substance out of which to make the filaments, have all ended in using carbon of either a fibrous or an amorphous consistency. The form of the filament has been governed by the need to hold within a bulb of given size a carbon of a given length. The filament must have a uniform section, and that is most certainly obtained in those which are formed by squirting a viscous solution of cellulose into a precipitating solution. The filament material is wound upon blocks of carbon and baked under great heat. Uniformity in resistance, securing equal consumption of current, of surface, and of incandescence, is also indispensable. To "flash" the filament for resistance, it is lowered into a glass chamber full of a hydrocarbon gas; it is heated by an electric current, and the carbon in the gas is deposited on the heated surface. In mounting the filaments, the important condition is to obtain a perfect electrical contact or joint between the metal and the carbon, and this is a very delicate point. The soldering is effected by electrically heating the joint in a vessel containing a liquid hydrocarbon surrounding, under such condition that the current shall pass through no part of the filament but the joint. Conditions opposite to those of an ordinary light are sought in inserting the filament in the bulb. Not rapid combustion but constant endurance of heating is wanted, and air is carefully removed by exhausting the bulb to one millionth of an atmosphere. In work, during the first two hundred hours of the life of the filament, the electrical resistance decreases slightly, and the brilliancy increases; for the next five hundred hours they are nearly stationary; after that, resistance increases and brilliancy decreases in a progressive ratio. The light is dimmed also by the gradual roughening of the surface of the filament and by the blackening of the glass from the deposition of carbon upon it.

Economical Plants of Australia.—With the exception of timbers, the economic vegetable products of Australia, as presented in Mr. Maiden's book on the Useful Plants of that country, are not of extraordinary importance. The northern regions, where the flora is re-enforced by representatives from the Malayan Archipelago and southern Asia, yield most of the plants possessing medicinal properties. The genus *Eucalyptus*, comprising more than one hundred and thirty species, yields excellent timber, kinos, and essential oils. *Eucalyptus gunnii* yields a sweetish sap which is converted by the settlers into excellent cider. This and manna, from two other species, are probably the only food products derived from eucalyptus trees. Oil from *Eucalyptus amygdalin* and *Eucalyptus globulus* is prepared in Australia and also in Algeria and California. In California it is available as a by-product in the manufacture of anti-calcaire preparations for boilers. The acacias of Australia, locally known as wattles, are hardly less useful than the gum trees. Immense numbers of them are destroyed for the sake of the bark used in tanning, and the leaves are greedily eaten by stock. By the operation of these two causes they are becoming scarce in some districts, and systematic attempts are now made to plant them on a large scale. Gum arabic of good quality is yielded by various species of acacia, but can not be profitably collected in the present condition of the labor market. Water is obtained by the natives for drinking, when springs fail, from the fleshy roots of a tree known botanically as *Hakea leucoptera* and from the stem of *Vitis hypoglauca*. Very few native Australian trees yield valuable fibers. The native mode of extracting fibers for their fishing-nets is by chewing with their teeth, and by this the teeth are "worn down to a dead level." The best fodder grass of Australia is the plant commonly known as "kangaroo grass."

Mistakes about Bearings.—Mistakes in orientation—sometimes of the most puzzling character—are usually the result of some incidental and temporary bewilderment, and may under peculiar circumstances overtake any one. Some instances have been cited by Sir Charles Warren in which they are chronic and may afflict even the best-informed persons. Erroneous conceptions formed by children as to distances and positions may grow up with them undetected till near maturity. Then, when the discovery is made, it is too late to apply any better remedy than to recognize the error and make allowance for it when possible. Cases are cited of a person whose ideas of certain parts of London were all inverted; of another, who placed Paris north of London; of thirty well-informed young men, "about eighteen were under the impression that, while the sun rises in the east, the stars rise in the west, from having learned that the sun has a proper motion among the stars; and the author believes that there are few educated men who have not grown up with some curious errors with reference to geographical facts, which have bothered them all their lives, and which they have found it to be impossible to get rid of." This defect may account for some of the accidents that occur on railways and shipping.

Mexican Leather.—A report of the Belgian minister in Mexico shows that the export of leathers from that country is increasing, and on account of the favorable conditions for cattle-raising that exist there is likely to continue to advance. The trade is just now suffering from the careless and defective manner in which the hides are treated before shipment. The trade in alligator-skins is capable of great development, and promises all the elements of a lucrative industry, because alligators or caymans are abundant in all the lagoons and cost nothing. Nearly all the parts of this animal are used. The teeth are made up, in conjunction with gold, into ornaments and articles of jewelry, which find a ready sale; medical properties are ascribed to the oil, and it is highly appreciated for the manufacture of soap; but the most important part is the skin, which is very strong and handsomely marked, and is used for shoes, bags, and fancy articles. The skin of the iguana also has a value, but is less consistent than that of the cayman.

Mesopotamian Peoples.—The population of southern Mesopotamia is divided by Dr. B. Moritz into three classes. The Bedouins of the desert live in dwellings made of black goat's hair, possess "wonderfully large" herds of sheep and camels, and pursue cattle-lifting as a national sport. The second class—the dwellers along the rivers and canals—form the settled agricultural element, and, although enjoying the smallest area of country, are the most numerous class of the population. They live in reed huts, which are a cross between the tent of the nomads and the permanent house. At the time of the great inundations they frequently leave their abodes and seek other places of residence, where the conditions as regards the waters are more favorable. Many also proceed in the summer into the desert, and only return in the winter to attend to their fields. Rice, barley, and wheat are cultivated. Rotten fish forms also a chief article of food. The third class of the population are the inhabitants of the marshes, whose sole employment is the pasturing of their buffaloes. They are human amphibia, who, like their cattle, subsist on the lower parts of the reeds and rushes, and, as a rule, wear only a felt cap, stiff with dirt, on their heads; they are otherwise generally unclothed. They live in little rush huts which are frequently situated in an impenetrable morass. Their civilization is an indescribably low one.

Cultivation of Lemons in Sicily.—The ever-bearing lemon of Sicily, according to the consular reports, produces blossoms and lemons every month in the year. Lemons are known as true and bastard. The "true" lemon is produced by the April and May blossoms, the "bastard" by the irregular blooms of February, March, June, and July, which depend upon the rainfall or regular irrigation and the intensity of the heat. The true lemon requires nine months—from May to January—to reach maturity. A first harvest of fruit takes place in November, when the lemons are green-colored and not fully ripe. These are the most highly prized and can be kept in the warehouses till March, and sometimes May, when they are shipped. A second lot is harvested in December and January, but these must be shipped within three weeks. The fruit of the third harvest, which occurs in March and April, is shipped at once, and enjoys the benefit of the high spring prices. The bastard lemons may be known by the peculiarities in their size and appearance. They are hard, rich in acid, and seedless; will remain on the tree a year, and sell well in summer; and some will remain on the trees for eighteen months. Four times more lemons than oranges are raised in Sicily, and the cultivation is thirty per cent more profitable.

Parasites of Hospitals.—The Abuse of a Great Charity is the title of a paper by Dr. George M. Gould on the greed with which the advantages of gratuitous hospital practice are sought by outdoor patients who are able to pay for treatment but are willing to "get something for nothing." Among the baneful results of the abuse are counted the encouragement of pauperism, dependence, and deceit in a large class already too prone to depend upon the state or charity instead of prudence or self-help; injury to the patient, from the hurried nature of the diagnosis which the physician is compelled to make, with the crowd pressing upon him; and to the physician, from the carelessness into which he is led; and degradation of the profession, by turning its practice into a sort of medical "free-lunch counter," by encouraging envy and subtle methods of advertising, and by the injustice of the system to younger and country practitioners. The author suggests a number of alternative remedies for the evil.

NOTES.

The second report of the Committee of the American Association on the spelling and pronunciation of chemical terms, as presented to the Indianapolis meeting, includes all the rules and categories of words given in the report to the Toronto meeting, but with the pronunciations of words as enumerated in that report usually omitted, unless they have evoked opinions at variance with the recommendations of the committee from more than one correspondent. As the list is limited, brief summaries of the reasons for divergent views are frequently appended, with indications of the authorities referred to. It is desirable that the next report of the committee should be thoroughly representative. The co-operation of all American chemists is therefore sought, and every chemist is requested to examine the list and note all variations from the spelling recommended that seem to him desirable.

Prof. H. W. Conn, in a paper on the Fermentations of Milk and their Prevention, notices, as an advantage arising from pasteurization that adds greatly to its value, that nearly all the pathogenic disease germs which are likely to occur in milk are killed by it. It is recognized that some of our dangerous epidemics are transmitted from house to house by means of milk, which furnishes a good medium for their growth. If pasteurization is sufficient to kill the disease-germs, and if at the same time it delays the souring from twenty to forty hours, and if the milk thus treated retains the taste of fresh milk, and permits the cream to rise on it in the natural way, it is plain that it is a process highly to be recommended. It consists in heating the milk to a temperature of about 155°, or a little higher, and then rapidly cooling it.

A telephone line has been laid between London and Paris, and is working successfully.

According to a paragraph in *La Nature*, the people of Brazil have domesticated a species of snake for the purpose of keeping down rats. It is the *giboia*, a kind of boa, which attains about thirteen feet in length, but is no thicker than one's arm. These snakes are sold for about a dollar apiece in the markets of Rio Janeiro, Pernambuco, and Bahia, They are inoffensive and graceful, and pass the day asleep. At night they begin their hunt, penetrating everywhere, even between the ceilings and the floors, and doing extensive execution on vermin. They learn to know their home, so that, when carried off, they are able to find their way back. They are said to be fixed in every house in the regions infested by rats, and to have especial individual qualities which the proprietor can boast of when he wishes to sell or let his place.

The Société d'Encouragement pour l'Industrie National, of Paris, France, has awarded Mr. Henry Marion Howe a prize of twenty-five hundred francs for his magnificent work on the metallurgy of steel. The first edition of this work was exhausted within a few weeks after its appearance. The second edition, just published, contains a few revisions by the author, and additions describing some recent advances in the processes of making steel directly from the ore. The work is published by the Scientific Publishing Company, New York.

Experiments recently made in a Prussian battalion have shown that dogs may be trained to hunt up the wounded after a battle, and call the attendants to take care of them. In training the dogs, certain soldiers pretend to be wounded, and lie upon the ground as they would do if that were the case. The dogs are sent out to hunt them; and when a dog finds a prostrate man he stands by him and barks till some of the ambulance-men come up. Every company of the battalion has twelve dogs trained in this way. Shepherds' dogs and wolf-dogs seem best adapted for this purpose, while very little can be made out of hunting-dogs.

The French Academy of Sciences has received a legacy of one hundred thousand francs from the late M. Cahours, the interest of which is to be distributed every year by way of encouragement to any young men who have made themselves known by some interesting works, and more particularly by chemical researches. A preference is expressed by the testator for young men without fortune not having salaried offices, and who, from the want of a sufficient income, would find themselves without the possibility of following up their researches. He also recommends that the money be given to the same young men doing satisfactory work, for several years—to cease, however, when they obtain sufficiently remunerative positions to make the aid unnecessary.

M. Charles Brongniart has communicated to the French Academy some observations on the peregrine locusts in Algeria, which passed continuously for several days over Mustapha and Algiers, and were so thick that one could not go into the street without being hit by them. To deposit her eggs, the female bores into the hardest ground, even in the trodden roads, sometimes trying the soil first, to the depth of from five to eight centimetres. She lines the bottom of the hole with a light whitish substance like beaten egg, and covers her eggs, after she has deposited them, with the same substance. In some places an average of thirty-five deposits per square decimetre was counted, each containing eighty or ninety eggs. The insects succumb immediately after laying, and shortly die; and the bodies lie scattered around at the rate of thirty per square metre, food for birds and predatory insects. The ground where the eggs have been deposited is easily recognizable from a distance.

A collection of Eskimo works of art, made by Assistant Superintendent Edwards of the cryolite mines at Arsuk Fiord, Greenland, is described by John R. Spears, in Nature. It includes candlesticks, cigar-holders, ash-receivers, anchors, paper-weights, etc, made of green-stone. The articles were all made to sell to the Danish rulers, for the Eskimo themselves have no use for ornamental art; but they show considerable skill in sculpture.

The Andaman Islands, constituting a small isolated territory, furnish rare opportunities for the study of the introduction and growth of new plants. They have been under scientific observation since 1858. Dr. Prain, of Silpur, records that in 1866, when there were six hundred known indigenous species, fifteen intentionally introduced plants and "sixty-one weeds of cultivation" had become established as an integral portion of the flora, and that by 1890 twenty-three more of the first class and fifty-six more of the second kind had been added, while four of the naturalized plants noted in 1866 had disappeared. A common Indian butterfly has made its appearance since the plant on which its larva feeds became naturalized.

A committee of London municipal officials has been ordered to report upon the advisability of erecting a crematorium in the cemetery at Ilford. Mr. Malthouse, one of the sanitary officials of the city, has called attention to the fact that 91,243 bodies were buried last year in the London cemeteries, and that in many places they lay fourteen deep. High medical authority had declared already that the state of the cemeteries demanded the intervention of the Government. Cremation, he said, was the only practical alternative of burial, and would soon be adopted, if the costs were reduced, as the prejudice against it was disappearing very rapidly.

An experiment has been made by Dr. Pringsheim, of Berlin, to determine the position of the accent in French words by a physical method. A phonautograph was used, into which a number of Frenchmen spoke, and the record was afterward measured by means of a tuning-fork curve running parallel to it. It was possible thus to determine the duration, pitch, and intensity of each syllable. As the results related to French words only, it may merely be mentioned here that the shortest syllable, *é*, in *été*, with rather a slow pronunciation, consisted of twenty-two vibrations; yet the ear, besides hearing the tone, is capable of detecting fine shades and differences in the mode of pronunciation.

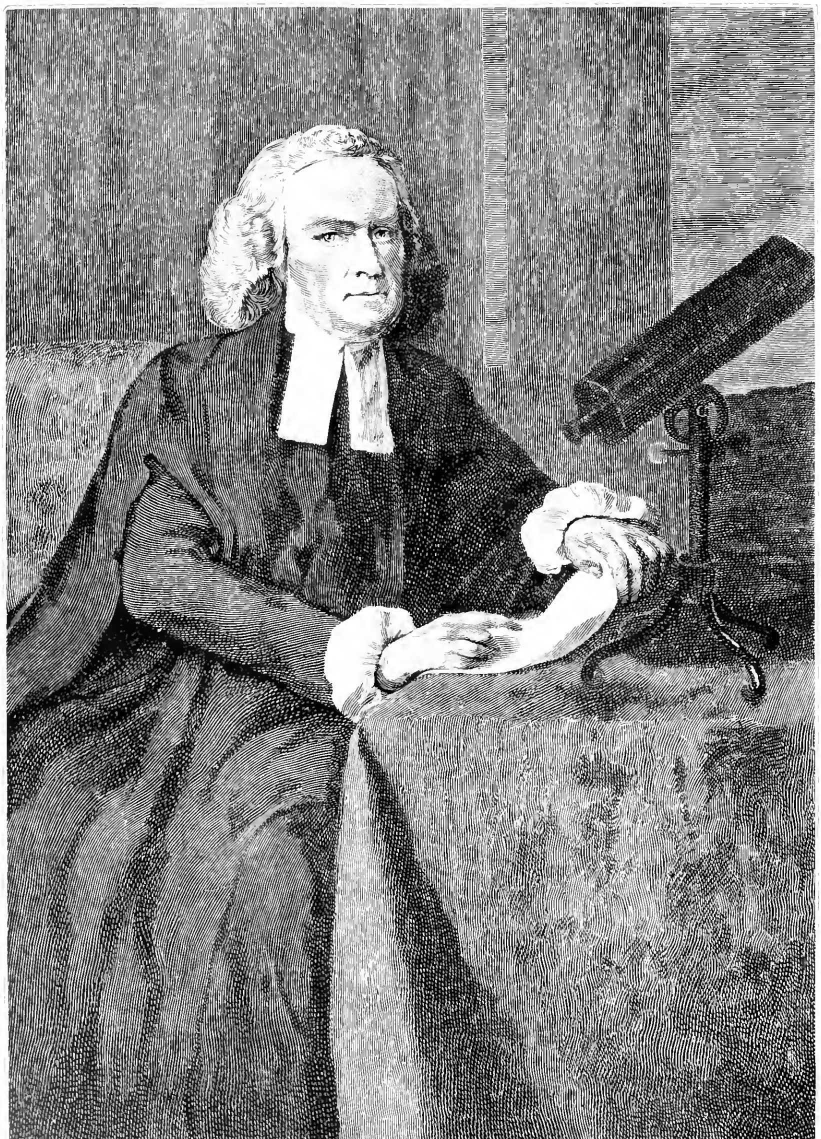
OBITUARY NOTES.

Dr. Richard Schomburgk, Director of the Botanic Gardens at Adelaide, South Australia, has recently died there. He was associated with his brother, the late Sir Robert Schomburgk, in the Boundary Demarkation of British Guiana in 1840; some years later settled in South Australia as a farmer and wine-grower; became Director of the Botanic Garden in 1866; founded the Museum of Economic Botany, and was an eminent horticulturist. He was author of a book in German of travels in British Guiana, in which were embodied a flora and fauna of the country; of Botanical Reminiscences of British Guiana; and of papers on the agricultural and horticultural capabilities of South Australia and the Botanic Garden.

The death is announced of Prof. Weber, of Göttingen, the celebrated physicist. He was born in 1802. His first scientific publication was the Theory of Modulations (Leipsic, 1825). Being a liberal in politics, he was turned out of his professorship by King Ernest of Saxony. He soon afterward began to devote himself to magnetism, gave a new impulse to the study of electricity in Germany, and became one of the first authorities on the subject in Europe. He was restored to his chair at Göttingen in 1849, and resided there for the rest of his life.

Prof. Carl Wilhelm von Nagelli, an eminent German botanist, died at Munich, May 10th, in the seventy-fourth year of his age.

Sir John Hawkshaw, an eminent English engineer, died in London, June 2d, in his eighty-first year. He was President of the Institution of Civil Engineers in 1862–1863, and of the British Association at its Bristol meeting in 1875. His greatest engineering feat was the construction of the Severn Tunnel.



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LESSONS FROM THE CENSUS.

By CARROLL D. WRIGHT, A. M.,

UNITED STATES COMMISSIONER OF LABOR.

I.

WITH the statement of the total population of the country, and of each State distributed as to counties, cities, and towns, the popular interest in the Federal census begins to wane, and, as the results relative to the features other than merely of enumeration are obtained, the scientific interest increases. This interest is entertained by all classes of students: the economist desires immediate results as to production, wealth, debt, taxation, etc.; the social scientist is looking for statements relative to color and race, conjugal condition, the death-rate and health of the people, and facts covering various other relations; and the statesman and politician are anxious to secure comparisons of the growth of population, the changes incident to new productive enterprises, the concentration of wealth, and all the other expansive elements which concern the great discussions in which they are engaged. Under the new census, the eleventh, the interest of other bodies is brought into activity. The question as to whether the homes and farms of the country are owned by the occupants, and the extent to which they are mortgaged, as well as the psychological reasons for incurring mortgage indebtedness, serves to interest, and in a most lively way, the student who is sociologically inclined. The enumeration of the surviving soldiers and the widows of deceased soldiers of the war of the rebellion brings into play not only the interest of the veterans themselves but of the legislators of the country, and, in addition, the sentiment of the whole community. All these various features of our Federal census excite the interest of the people on a broader scale and in more thoroughly scientific directions than would the enumeration of the people alone. Crystallized statements, and a somewhat popular analysis of the results of the census as they come out, must be of more or less value, and from them many lessons may be drawn. A series of articles, therefore, comprehending comparisons and analyses, and bringing out the salient points in all the vast quantity of material digested by the Census Office, can not fail to interest various elements of the population. It seems wise, however, before entering upon a discussion of the statistical features and of the scientific results of the census and the lessons to be drawn therefrom, that these first two chapters should be devoted to the system under which all these various results are obtained.

The United States census finds its organic authorization in the Federal Constitution, in accordance with Article I, section 2, as follows:

"Representatives and direct taxes shall be apportioned among the several States which may be included within this Union, according to their respective numbers, which shall be determined by adding to the whole number of free persons, including those bound to service for a term of years, and excluding Indians not taxed, three fifths of all other persons. The actual enumeration shall be made within three years after the first meeting of the Congress of the United States, and within every subsequent term of ten years, in such manner as they shall by law direct."

The only other reference in the Constitution to a census is in section 9 of Article I, wherein it is provided that "no capitation or other direct tax shall be laid, unless in proportion to the census or enumeration hereinbefore directed to be taken." This organic provision for a periodical census was the first of its kind in any country. It was the result of a good deal of discussion by the framers of the Constitution, and grew out of the difficulties which they experienced in apportioning representatives and taxation. There were wide differences of opinion in the Constitutional Convention; but after much deliberation the majority settled upon the form of language just quoted, and it became a part of the organic law of the land. There had been, prior to the adoption of the Constitution in 1789, various colonial and local censuses, and foreign countries had made enumerations at intervals of time; so that the framers of the Federal Constitution were not particularly unfamiliar with the benefits of census-taking; but the credit of the first regularly organized periodical census is due to the United States, and this country has had, commencing with 1790, regular enumerations of population, and since and including 1850 what might be denominated national censuses, comprehending various features other than the mere enumeration of the inhabitants of the country.

The general direction of the census was placed in the hands of the Secretary of State, where it remained until the passage of the census law of May 23, 1850, when all the functions of census-taking were put in charge of the newly created Department of the Interior, and all census laws since and including that have been administered under the direction of the Secretary of the Interior. The first schedule, that for 1790, was a very simple affair, and was as follows:

Schedule of the Whole Number of Persons within the Division allotted to A. B.

(1790.)

Names of heads of families.	Free white males of 16 years and upward, including heads of families.	Free white males under 16 years.	Free white females, including heads of families.	All other free persons.	Slaves.

In 1800 the scope of the population schedule was enlarged somewhat, and it was used in the following form:

Schedule of the Whole Number of Persons within the Division allotted to A. B.

(1800.)

Name of the county, parish, township, town, or city, where the family resides.	Name of head of family.	Free white males under 10 years of age.	Free white males of 10 and under 16.	Free white males of 16 and under 26, including heads of families.	Free white males of 26 and under 45, including heads of families.	Free white males of 45 and upward, including heads of families.	Free white females under 10 years of age.	Free white females of 10 years and under 16.	Free white females of 16 and under 26, including heads of families.	Free white females of 26 and under 45, including heads of families.	Free white females of 45 and upward, including heads of families.	All other free persons, except Indians, not taxed.	Slaves.

The foregoing schedule was used in 1810 without change, but the scope of the census, by act of May 1, 1810, was enlarged. This act required the several marshals, secretaries, and their assistants, "at the time for taking the census or enumeration aforesaid, to take, under the direction of the Secretary of the Treasury, and according to such instructions as he should give, an account of the several manufacturing establishments and manufactories within their several districts, territories, and divisions"; but no schedule was incorporated into the law, the whole matter being left to the discretion of the Secretary of the Treasury as to construction. No very valuable results were obtained under this provision; yet the experiment was repeated in 1820, under the law of March 14th of that year, which made it the duty of the "several marshals and their assistants, at the time for taking the said census, to take, under the direction of the Secretary of State, and according to such instructions as he shall give, and such forms as he shall prescribe, an account of the several manufacturing establishments and their manufactures, within their several districts, territories, and divisions." These attempts to enlarge the census so as to include statistics of manufactures were so barren of valuable results that in taking the census of 1830 the attempt was wholly abandoned. The manufacturers' schedule was, however, introduced again in 1840; but still the effort was of little account, and it was not until the census taken under the broader law of 1850 that any valuable results were reached. So the census grew, from the simple enumeration of the people in 1790, under the very brief schedule which has been given, not only through various additions to the population schedule, but by the introduction of inquiries relating to production, until nearly all the material conditions surrounding the people, their industries, their wealth, their taxation, their carrying trade, fisheries, schools, health—nearly everything, in fact, that the social scientist wishes to know concerning the people and their conditions—are embodied in the census. With the changes in the scope of the census there have been changes in the methods of enumeration. Until 1880 the United States marshals for the several districts were authorized, under the first census law, approved May 1, 1790, to make the enumeration, the marshals having power to appoint as many assistants within their respective districts as should appear necessary. The enumeration was to commence on the first Monday in August, 1790, and it was provided by law that it should close within nine calendar months thereafter. The marshals were required to file the returns with the clerks of their respective district courts for careful preservation, and to forward the aggregate amount of each description of persons within their respective districts to the President of the United States. Each assistant marshal was required, previous to making his return to the marshal, to cause a correct copy of the schedule, signed by himself, to be set up at two of the most public places within his division, there to remain for public inspection. The use of United States marshals in taking the censuses was continued until the tenth census, that of 1880, although an effort was made to provide other machinery for the ninth census, that of 1870. This effort was embodied in a bill which passed the House of Representatives, but which was defeated in the Senate; so the census of 1870 was taken in accordance with the law of 1850. The act for the tenth census, approved March 3, 1879, provided that enumerators, specially appointed for the purpose, should make the canvass, the body of enumerators working under supervisors appointed by the President. Under this law there were one hundred and fifty supervisors, under whom were employed about thirty thousand enumerators, and under the last-named law the scope of the census was greatly expanded, nothing like it ever having been carried out under any government. The enumerators were to make the canvass from house to house, from manufactory to manufactory, from farm to farm, sending their certified returns to their respective supervisors, who, after careful examination, transmitted the originals to the superintendent at Washington. By this method the central office was put in possession of the original data, avoiding thereby all the errors incident to transcription under previous methods. General Francis A. Walker was the superintendent, and he was also the superintendent of the ninth census, that of 1870. He carried through the census of 1880 on the broad basis laid down by him, and the results, in twenty-two folio volumes, secured for him the admiration of statisticians in every part of the world.

Now comes the eleventh census, the centennial of that of 1790. It is being conducted under a law which is practically the re-enactment of that providing for the tenth census. The law was approved March 1, 1889, and under it Robert P. Porter was appointed superintendent. The schedules are practically those of the tenth census, enlarged, amended, and improved as experience under the tenth census indicated the necessity.

The growth of the Federal census, while clearly illustrated by reference to the various laws, is perhaps more strikingly shown by a statement of the various publications which have resulted from the several censuses. General Garfield, chairman of the Committee on the Ninth Census, made in January, 1870, a very elaborate report covering census-taking in different countries in the world, and especially a history of the United States censuses; and from this report the exhibit relative to publications and expenses up to and including 1860 is taken. For 1870 and 1880 recourse has been had to original sources:

1790.—Return of the Whole Number of Persons within the Several Districts of the United States, etc. This first census publication was an octavo pamphlet of 52 pages, published in 1792. The entire cost of this census was $44,377.18.

1800.—Return of the Whole Number of Persons within the

Several Districts of the United States, etc. This was a folio of 78 pages, published in 1801. The cost of this census was $66,609.04.

1810.—The report of this census was in two folio volumes: I. Aggregate Amount of each Description of Persons within the United States, etc. This was an oblong folio of 90 pages, but it does not show the date of publication. II. A Series of Tables of the Several Branches of American Manufactures, exhibiting them in every County of the Union, so far as they are returned in the Reports of the Marshals and of the Secretaries of the Territories, and of their Respective Assistants, in the Autumn of the Year 1810; together with Returns of Certain Doubtful Goods, Productions of the Soil and Agricultural Stock, so far as they have been received. Quarto, 170 pages. Edited by Tench Coxe, and published May 30, 1813. The cost of the census of 1810 was $178,444.67.

1820.—I. Census for 1820, etc., a folio of 164 pages, published in 1821. II. Digest of Accounts of Manufacturing Establishments, etc., a folio of 100 pages, printed in 1823. Cost of the census, $208,525.99.

1830.—Fifth Census or Enumeration of the Inhabitants of the United States. This volume was a large folio of 163 pages, printed in 1832. This report was so wretchedly printed that Congress required by law a republication, which was made the same year, under the immediate direction of the Secretary of State. The erroneous and corrected editions are bound together. This republication enhanced the cost of this census to $378,543.13.

1840.—I. Compendium of the Enumeration of the Inhabitants and Statistics of the United States, a folio of 379 pages, printed in 1841. II. Sixth Census or Enumeration of the Inhabitants of the United States, a folio of 470 pages, 1841. III. Statistics of the United States, etc., a large, oblong folio of 410 pages, 1841. IV. Census of Pensioners for Revolutionary and Military Service, with their Names, Ages, and Places of Residence, etc. Quarto, 196 pages. The total cost of these censuses was $833,370.95.

1850.—I. The Seventh Census of the United States, quarto of 1022 pages, 1853. II. Statistical View of United States, octavo of 400 pages, 1854. III. Mortality Statistics of the Seventh Census, etc., octavo, pp. 304, 1855. IV. Digest of the Statistics of Manufactures, octavo, pp. 143, published in 1859 as Senate Executive Document, No. 39, second session Thirty-fifth Congress. Cost up to September 30, 1853, $1,318,027.53. There were three or four subsequent appropriations for this census, amounting to about $11,000.

1860.—I. Preliminary Report of the Eighth Census, 1860, octavo, 294 pages, 1862. II. Final Report, in four quarto volumes, as follows: Vol. I. Population, pp. 694. Published in 1864. Vol.

II. Agriculture, pp. 292. Published in 1864. Vol. III. Manufactures, pp. 746. Published in 1865. Vol. IV. Mortality and Miscellaneous Statistics, pp. 548. Published in 1866.

The total cost of the eighth census was, in round numbers, $2,000,000.

1870.—The results of the ninth census were embodied in three quarto volumes, as follows: Vol. I. Population and Social Statistics, pp. 875. Published in 1872. Vol. II. Vital Statistics, pp. 705. Published in 1872. Vol. III. Statistics of Wealth and Industry, pp. 849. Published in 1872.

The cost of the ninth census, including printing, was $3,696,-227.37.

1880.—The results of the tenth census made an encyclopedic report of twenty-two quarto volumes and a compendium.

The cost of the tenth census, including printing, was $5,862,-750.24.

The eleventh census, that for 1890, is being taken under the act approved March 1, 1889, and comprehends all the features of the tenth, with two great additions—an account of the mortgage indebtedness on homes and farms, and an enumeration of the surviving veterans of the war of the rebellion. The machinery of the census is practically the same as that organized for the tenth. The forces employed, however, are vastly greater, numerically considered. The number of supervisors was increased to 175. The whole body of enumerators constituted an army of 46,546. The largest number of office employés, not including special agents, was on May 9, 1891, 3,142; and the number of special agents, including special agents on manufactures in cities, was 1,938, or a total force June 1, 1891, exclusive of enumerators, of 5,080. The appropriations, up to July 1, 1891, have been $7,400,000. To complete the work there will be required another and quite large appropriation. The organization of the Census Office, January 1, 1891, comprehended twenty-five specific divisions, each division being under the charge of a chief of division or an expert special agent. These twenty-five divisions are charged with the business features of the Census Office, and the collection and tabulation of the facts relating to the subjects indicated in the following list:

First Division.—Appointments.
Second Division.—Disbursements and Accounts.
Third Division.—Geography.
Fourth Division.—Population.
Fifth Division.—Vital Statistics.
Sixth Division.—Church Statistics.
Seventh Division.—Educational Statistics.
Eighth Division.—Pauperism and Crime.

Ninth Division.—Wealth, Debt, and Taxation.
Tenth Division.—National and State Finances.
Eleventh Division.—Farms, Homes, and Mortgages.
Twelfth Division.—Agriculture.
Thirteenth Division.—Manufactures.
Fourteenth Division.—Mines and Mining.
Fifteenth Division.—Fish and Fisheries.
Sixteenth Division.—Transportation.
Seventeenth Division.—Insurance.
Eighteenth Division.—Printing and Stationery.
Nineteenth Division.—Statistics of Special Classes.
Twentieth Division.—Supervisors' Correspondence.
Twenty-first Division.—Alaska.
Twenty-second Division.—Statistics of Indians.
Twenty-third Division.—Social Statistics of Cities.
Twenty-fourth Division.—Accounts, Farms, Homes, and Mortgages.
Twenty-fifth Division.—Revision and Results.

The progress of this vast work is probably at the present writing in as forward a state as could be expected, when the volume of data called for, as indicated, is considered. The results—showing aggregate population by States, counties, and minor civil divisions, and by sex; condensed classification by ages, showing the school, militia, and voting ages, by native and foreign white persons and colored persons—will be put into compendium form and published, without much doubt, before the close of the present calendar year. The classification regarding families and dwellings, the volume of final reports for population, showing the results in detail, by ages, conjugal condition, place of birth, and all the varied distinctions of population, must not be expected until some time in 1892, possibly by the early summer. All this work is enough for the Census Office to handle at one time; but when there is added to it the multitudinous divisions shown in the foregoing list, it is not to be wondered at that progress is slow, that the country criticises, and that increased appropriations are called for. No superintendent, burdened with the present system, can possibly satisfy the country, Congress, or himself. And so the first lesson to be drawn from the census relates to the system rather than to the results under it, and to what changes are needed that the system may be improved.

A recent find of mummies of dogs in Egypt has prompted M. Maspero to suggest that these objects may furnish opportunities for studying the characteristics of the most ancient of the domesticated species. Some efforts have been made to determine these from the wall-paintings, but the data they afford are very uncertain.

THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

VIII. THE MANUFACTURE OF STEEL.

By WILLIAM F. DURFEE, Engineer.

IT is now two hundred and thirty-six years since the first American steel maker of which we have any record, Mr. John Tucker, of Southold, Long Island, informed the General Court of Connecticut of his "abilitie and intendment to make steele there or in some other plantation in this jurisdiction, if he may have some things granted." The court (says Bishop) acquiesced in a grant of privileges, and, in the following May, Tucker obtained from the Assembly a declaration "that if he doe laye out his estate in such a manner about this publique worke, and that God shall cross him therein so that he be impoverished thereby, they are willing that that small remaining part shall be free from rates for ten years."* Possibly Tucker thought that the "protection" guaranteed by the colony was not sufficient, as we have no evidence that he ever availed himself of it, or was ever "impoverished thereby."

In 1728 Samuel Higley, of Simsbury, and Joseph Dewey, of Hebron, in Hartford County, Connecticut, represented to the Legislature that the said Higley had, "with great pains and cost, found out and obtained a curious art by which to convert, change, or transmute common iron into good steel sufficient for any use, and was the first that ever performed such an operation in America."† Swank gives on the authority of Mr. Charles J. Hoadly, Librarian of the Connecticut State Library, a certificate, signed by Timothy Phelps and John Drake, blacksmiths, which states that, in June, 1725, Mr. Higley obtained from the subscribers several pieces of iron, so shaped that they could be known again, and that a few days later "he brought the same pieces which we let him have, and we proved them and found them good steel, which was the first steel that ever was made in this country that we ever saw or heard of."

A patent was granted Higley and Dewey for ten years, pro-

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* New Haven Colonial Records, vol. ii, p. 173.

† Bishop tells us that "the first patent granted in England for the manufacture of steel was to Richard Lord Dacre, Thomas Letsome, and Nicholas Page, on 8th April, 1626, for apparatus for making steel, according to the inventure of Letsome." In 1655 "there was but little steel made in England, and that very imperfectly and all of foreign Iron." Forty years after (in 1695) English writers speak of steeling articles by "boiling them in raw metal," and steel was made by a similar process, and was "made by cementation by John Heydon, at Bromley, in 1697."

vided "the petitioners improve the art to any good and reasonable perfection within two years from the date of this act." They do not appear to have done this, or to have continued the business of making steel.

In 1740 the Connecticut Legislature granted to Messrs. Fitch, Walker & Wyllys "the sole privilege of making steel for the term of fifteen years upon this condition, that they should in the space of two years make half a ton of steel"; this condition not having been complied with, the privilege was extended to 1744, before which time Aaron Eliot and Ichabod Miller certified that more than half a ton of steel had been made at the furnace in Symsbury.

Some time before 1750 a steel-furnace was in operation at Killingworth, in Middlesex County, Connecticut. This furnace (says Swank) was owned by Aaron Eliot, and in it he succeeded, in 1761, in converting into good steel a bar of iron, made in a blomary fire from magnetic sand, by his father, the Rev. Jared Eliot.

Mr. Swank quotes from Mr. Hoadly a petition presented to the Legislature of Connecticut in May, 1772, by Aaron Eliot, in which the petitioner recites that his capital "has not been large enough to supply himself with a sufficient stock to carry on his business, & has, therefore, hitherto been obliged to procure his stock of iron from New York on cred[t], and pay for the same in his steel, when made, at the moderate price of £56 per ton [186.66\frac{2}{3}$, the £ being equal to 3.33\frac{1}{3}$], from whence it has been again purchased in this Colony at the price of £75 and £80 per ton; and, for several years past, almost the whole supply of steel in this Colony has been from New York, of the manufacture of your memorialist, at the afores[d] enormous advance." He accordingly begs for a loan of £500 from the public treasury for three years without interest; this, he says, would "save large sums of money within this Colony, which is annually paid to New York for the steel manufactured in this Colony."

Eliot's prayer was granted, and in 1775 the loan was renewed for two years longer. It appears from returns made by the Colonial Governors in 1750, in conformity with the Act of Parliament, that Massachusetts, Connecticut, and New Jersey had each one steel-furnace, and Pennsylvania two; both of these were in Philadelphia, owned by William Branson and Stephen Paschal, respectively. Branson stated in regard to his steel that "the sort he made, which was blistered steel, ten tons would be ten years in selling." Paschal's furnace was built in the year 1747, on a lot at the northwest corner of Eighth and Walnut Streets; this furnace in 1787 was owned by Nancarrow & Matlock, when it was visited in that year by General Washington, and said to have been "the largest and best in America." Whitehead Humphreys, who in 1770 was the owner of a steel-furnace on Seventh Street, Philadelphia, and made steel for the Continental army, was granted in 1786, by the Legislature of Pennsylvania, a loan of £300 for five years, to aid him in making steel from bar iron "as good as in England."

In 1777 Rhode Island "gave £60 per gross ton for good German steel made within the State." *

The Legislature of Massachusetts granted in 1778, to the Rev. Daniel Little, "£450, to aid in erecting at Wells [in the District of Maine] a building 35 × 25 feet, to be used in manufacturing steel." †

In 1787 the manufacture of steel was commenced in the town of Easton, Massachusetts, by Eliphalet Leonard, and we are told by Bishop that "the article was made in considerable amount, and cheaper than imported steel." About 1797 steel was made at Canton, in the same State, "from crude iron, by the German process." Peter Townsend, the proprietor of the Sterling Iron Works, in New York, made in 1776 the first steel produced in that province, and his son, Peter Townsend, Jr., is said to have made, at the same works, in 1810, steel "of as good quality for the manufacture of edged tools as that made from Dannemora iron."

Alexander Hamilton, in a report dated December 5, 1791, says, "Steel is a branch which has already made considerable progress, and it is ascertained that some new enterprises on a more extensive scale have been lately set on foot." In the same year Tench Coxe, in replying to Lord Sheffield's Observations on the Commerce of the United States stated that "about one half of the steel consumed in the United States is home-made, and new furnaces are building at this moment."

Swank states that "in 1805 there were two steel-furnaces in Pennsylvania which produced annually one hundred and fifty tons of steel. One of these was in Philadelphia County. In 1810 there was produced in the whole country nine hundred and seventeen tons of steel, of which Pennsylvania produced five hundred and thirty-one tons in five furnaces. . . . The remainder was produced in Massachusetts, Rhode Island, New Jersey, Virginia, and South Carolina; each State having one furnace. In 1813 there was a steel-furnace at Pittsburgh, owned by Tuper & McKowan, which was the first in that city."

All the steel manufactured in America prior to the year 1810 was produced either by what was called the "German method," which was conducted in a "hearth" similar to that used for a "blomary fire," or by the "cementation process." The "Ger-

* Economic and Social History of New England, 1620–1789, by W. B. Weeden. † Ibid.

man steel" was made directly from the ore or a suitable quality of "pig iron" was used. The operation, when ore was employed, consisted in removing the oxygen, and then by appropriate manipulation, together with a regulation of the blast and heat, the iron was combined with carbon derived from the fuel to such a degree as to convert the metal into a mass of crude steel; this was carefully drawn under a light, quick-working hammer into bars about an inch square; six or eight pieces of these bars were made into a "pile," welded together, and drawn into smaller bars. This process, called "refining," was repeated a number of times, and the quality of the resulting steel was designated by the terms "single," "double," or "triple refined," according to the number of weldings and hammerings. When "pig iron" was used, the operation consisted in so manipulating the metal and regulating blast and heat that a portion of the carbon in the "pig" remained in the resulting "bloom" of crude steel, which was subjected to the same "refining" as has just been described.

All the early attempts to make steel in America were in the "German manner"; but it was soon discovered that the ores and pig irons available were not of a proper quality, and attention was early directed toward the "cementation process," the details of which were fully described by Réaumur in 1722.*

The operation of making "cemented" or "blister" steel consisted essentially in packing bars of wrought iron in charcoal-dust in long boxes or "pots" made of sandstone or fire-brick. These "pots" were covered as nearly air-tight as possible and subjected to a high degree of heat (not, however, sufficient to melt the bars of iron), which was regulated as to temperature and duration according to the contemplated use to be made of the steel. As a rule, the higher the temperature and the longer time it was kept up, the greater the degree of carburization of the bars in the "pots" and the harder the resulting steel. When the iron is packed in the charcoal, one or more bars are allowed to project through openings in one end of the "pots"; these bars are removed at proper intervals of time, and from their appearance when cold the progress of the operation was judged. When the process of "cementation" was finished, the furnace was allowed to cool, and, as soon as men could work therein, the metal was removed from the "pots," and it was found that it had undergone a great change: instead of having a smooth surface, it was covered with a large number of "blisters" of varying size and thickness (hence the name "blister steel"), and, although when put into the "pot" the metal was very fibrous and tough, it was found

* L'art de convertir le fer forgé en Acier, et l'art d'adoucir le fer fondu, ou de faire des Ouvrages de fer fondu aussi finir que de fer forgé. Par Monsieur de Réaumur, de l'Académie Royale des Sciences. A Paris, 1722.

on removal to be very crystalline and brittle. These changes of structure and fracture were due to the absorption of carbon from the charcoal dust in which the bars had been packed.

Fig. 50 is a cross-section of a "cementation" or "blister-steel" "converting furnace," in which the various parts are so plainly designated that additional description is unnecessary. The degree of carburization, and consequently the hardness of the steel produced in such a furnace, necessarily varied, and for the convenience of manufacture and trade the product was assorted into six grades or "heats." *

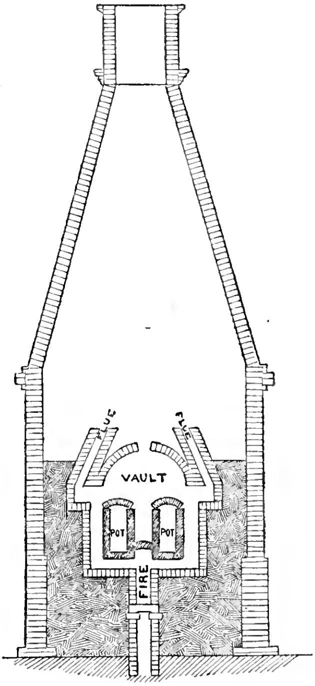

FIG. 50.—CROSS-SECTION OF A CONVERTING FURNACE FOR BLISTER STEEL.

When steel was wanted of closer grain, firmer texture, and more reliable character, a certain number of bars of this "blister steel" were made into a bundle or "fagot" and welded together, and the resulting bar was called "single shear" steel; and if a still higher quality was required, bars of "single shear" were welded and drawn into bars called "double shear steel." †

Previous to the year 1812 we have no record of there having been any steel produced in America by other than the processes already described, but in that year John Parkins and his son, Englishmen, "are said to have made an unsuccessful attempt to make *cast steel* in New York City," ‡ and the same authority tells us that they were employed, in 1818, at Valley Forge, Pa., to make *cast steel* for a saw manufactory.

In 1831 John R. Coates, of Philadelphia, stated that there were then in the United States fourteen blister-steel furnaces, which had "a capacity sufficient to supply more than sixteen hundred tons of

* No. 1, spring heat, about ½ per cent carbon; No. 2, country heat, about ⅝ per cent; No. 3, single shear heat, about ¾ per cent; No. 4, double shear heat, about 1 per cent; No. 5, steel through heat, about 1¼ per cent; No. 6, melting heat, about 1½ per cent.

† Percy and other writers on the manufacture of steel have stated that the term "shear steel" originated from the fact that such steel was used in making the blades of shears; but, as steel of the same quality was employed for multitudes of other implements, and as "blister steel" was made in Germany before it was in England, it appears to the writer more probable that the result of refining and improving its quality by successive weldings received the German appellation of *Sicher-stahl* (sure, or trusty steel), which was mistranslated into the English term "shear steel."—W. F. D.

‡ Swank—Iron in All Ages.

steel annually, an amount equal to the whole importation of steel of every kind. . . . The only steel now [1831] imported from Great Britain is of a different and better quality than that just mentioned." *Cast steel* was not then made in the United States. This variety of steel was invented in England, by Benjamin Huntsman, in 1740. Mr. Huntsman was a watch-maker, and also made clocks, roasting-jacks, and other mechanical contrivances.

The invention of Huntsman consisted substantially in breaking "blister steel" into small fragments, placing these in a crucible, and subjecting that to sufficient heat to render its contents perfectly fluid; the fluid steel was then poured (or "teemed") into a cast-iron mold. Melting the "blister steel" removed all its solid infusible impurities, and when the ingot which resulted from the "teeming" (or "casting," hence the term cast steel) was hammered or rolled, the product was found to be much more homogeneous, and the temper more uniform, than was ever the case in steel made by the old welding process. The first attempt to produce "cast steel" in America that is fairly entitled to be called successful was made by the brothers William and John Hill Garrard, natives of England, who in August, 1832, commenced the manufacture of "cast steel" in works located on the Miami Canal, at Cincinnati.

Metallurgical history is indebted to James M. Swank * for a full account of these works, including a statement of Dr. William Garrard, who was living in 1884. As to the commercial success of his manufacture, Dr. Garrard says: "I sold my steel and manufactured articles principally to manufacturers. There were some wholesale houses that bought of me, but they were importing houses, and when the Sheffield manufacturers found that I was making as good steel and manufactured saws and files as good as they did, they gave our merchants such an extended time of credit that they bought as little as possible from us." The Cincinnati Steel Works, as this establishment was called, continued in operation until 1844, although in the last seven years of their existence the principal product was blister steel. That the cast steel made in these works was of excellent quality there is abundant proof.

It is impossible within the space available to give in detail an account of the many attempts that were made in various parts of the country, but chiefly in Pennsylvania, between the years 1830 and 1860, to manufacture steel of the best quality. The reasons for the almost uniform failure can now be very easily assigned; there was a universal ignorance of chemistry and a consequent contempt for its teachings, and the experimenters had not sufficient knowledge of practical metallurgy to utilize their occasional

* In Iron in all Ages.

successes, or to draw intelligent inferences from their much more common failures. One somewhat prominent firm was so persistent in their ignorant faith that a certain iron was the best in America that, when they discovered that good steel could not be made therefrom, they abandoned an enterprise in which many thousands of dollars had been expended, because they firmly believed that they had demonstrated that it was impossible to make cast steel from American iron.

Swank tells us that in 1850 there were thirteen steel works in Pennsylvania which produced in that year 6,078 tons, of which but 44 tons were "cast steel." According to the same authority, the "Adirondack Iron and Steel Company, whose works were at Jersey City, N. J.," succeeded in February, 1849, in making "cast steel" in black-lead crucibles by melting "blister steel," made from iron that had been puddled with wood as the fuel. "Of the excellent quality of the "cast steel" manufactured at this time at these works there is abundant evidence in the testimony of Government experts and of many consumers. . . . It was used for chisels, turning and engravers' tools, drills, hammers, shears, razors, carpenters' tools, etc. Its manufacture was continued with encouraging results until 1853, when the business was abandoned by the company. It had not proved to be profitable, partly because of the prejudice existing against American 'cast steel,' and in some degree to the irregularity of the temper of the steel produced." The firm of Hussey, Wells & Co., of Pittsburg, began the erection of works in 1859, and in the following year they entered upon a successful business in the making of crucible cast steel of the best quality from American iron. In 1862 the firm of Park Brothers & Co., also of Pittsburg, achieved success with the same material. These were the first firms in America who were commercially as well as mechanically successful in the manufacture of "cast steel." Their works are still in operation and their products are well and favorably known.

There are various methods of making "crucible cast steel" besides that already mentioned as the discovery of Huntsman; one of these, which is in very common use, consists of melting in a plumbago crucible a certain weight of wrought iron cut into small pieces together with a sufficient amount of charcoal powder to properly carburize it during the process of fusion. Another method is to melt together proper proportions of "pig" and "wrought" iron. In all of the modern processes of making "cast steel" manganese enters in some form, its chief use being to effect the removal of any oxygen that may be present in the metal used.

We shall not attempt a description of the multitudes of "mixtures," "fluxes," and "physics," each intended to work wondrous beneficent changes in material positively bad, and to so purify and purge it that it would inevitably produce steel phenomenally good, that wearied the minds, vexed the souls, and too often imparted a lurid hue and sulphurous flavor to the language of the early makers of cast steel. These nostrums represented every school of "medicine"; one prescribed heavy doses of certain "salts," another was loud in the praises of minute pellets of his most potential preparation; one of the advocates of the botanical treatment extolled the efficacy of a raw potato to "agitate the metal" * and cause it to throw off all its superfluities, while the "eclectics" roamed through all the fields of "physic" and claimed to appropriate all the virtues and ignore the vices of the other practitioners.

The original method of melting cast steel consisted in placing a single "pot" with its contents in a square vertical furnace, or "hole," whose top was level with the floor of the "casting house"; the furnace was then filled with either coke or anthracite coal, care being taken that the fuel was distributed equally on all sides of the "pot," which was provided with a "lid" to protect its contents from contamination by the entrance of coal or other matter.

The fire was then urged by the powerful draught of a chimney, or frequently by a "blower." Many of the later "melting holes," in which solid fuel was used, were made large enough to contain two, and some of them four "pots."

All the cast steel made in America prior to the year 1868 was melted by solid fuel in "holes" such as have been described; but in November, 1867, Messrs. Anderson and Woods, of Pittsburg, procured a license from the American owners of the Siemens patents for "regenerative gas furnaces," and under this license a "twenty-four pot" melting furnace was erected under the supervision of William Durfee,† in their works at Pittsburg, Pa., in the spring of 1868, according to plans prepared by J. Thorpe Potts, C. E., who represented Dr. Siemens in America. This was the pioneer furnace in the United States using gaseous fuel for melting cast steel, and its success led to their rapid introduction in other works, so that to-day there are not many of the old-fashioned "holes" using solid fuel to be found.

In Fig. 51 we have a vertical cross section of a "Siemens regenerative gas furnace" for melting cast steel. Fig. 52 is a top view of the furnace, showing two of the "melting holes" covered and six "pots" in place in the open hole; the top of the furnace

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* Another "crank" claimed to have discovered a liquid in which if "pigs" of iron were "soaked" a certain time they would be cleansed of all their impurities, and could then be converted into steel by simple fusion. This might have been with propriety called the "hydropathic process."

† Father of the writer.

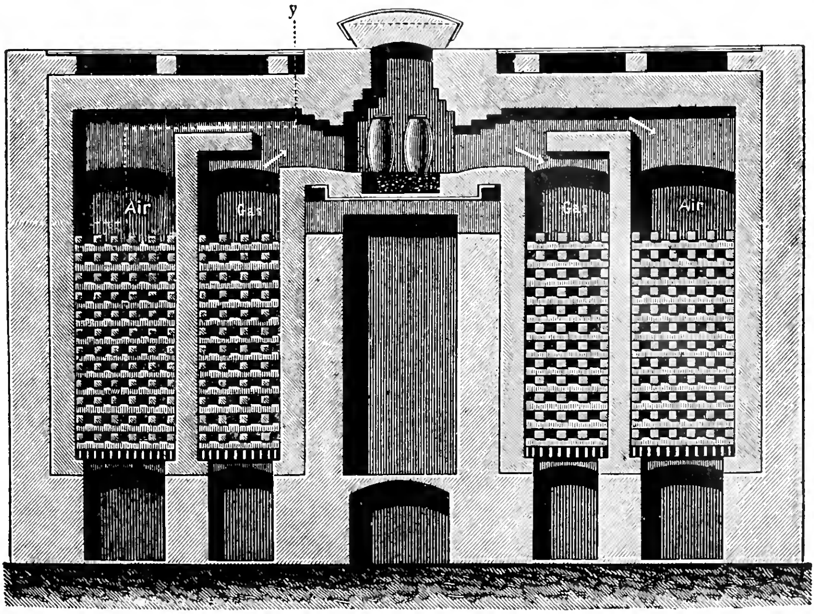

FIG. 51.—VERTICAL CROSS-SECTION OF A SIEMENS FURNACE FOR MELTING STEEL IN POTS.

on the left having been removed to show the flues. The distinguishing peculiarity of the "Siemens furnace" is the method of utilizing the escaping heated products of combustion for heating the incoming gas and air. This is accomplished by what are called the "regenerative chambers," which are situated to the right and left of, and at a lower level than, the "melting holes." As will be seen in Fig. 51, there are four of these chambers, the two smaller being for gas, and the two larger for air.

Air enters the flue at the lower part of the left-hand chamber, and, passing upward, it absorbs whatever heat may be in the reticulated mass of fire-brick with which the chamber is filled, and, on reaching its top, it turns to the right in the direction of the arrow, and, just previous to entering the "melting hole," it encounters and combines with the incoming gas, which also has been highly heated by contact with the bricks in the "gas chamber." The result is the ignition of the gas immediately at the entrance to the "melting hole"; intense combustion ensues, the ignited gas expanding and completely enveloping the "pots," and the highly heated products of this combustion leave the "melting hole" on the side opposite to that at which they entered, and on their way to the chimney they pass through each of the right-hand chambers of the furnace, and in their passage raise the bricks therein to a high temperature.

After the furnace has worked for a proper time in the way described, the brick-work in the left-hand chambers will have become considerably cooled, and then the "melter" reverses certain valves (not shown in the figures), causing the currents of gas and air to be reversed—that is to say, the gas and air will now come in through the right-hand chambers and pass out through the left. In this way a very intense heat is maintained in the "melting hole," which can be regulated at pleasure by varying the amount and proportion of the gas and air used. The advan-

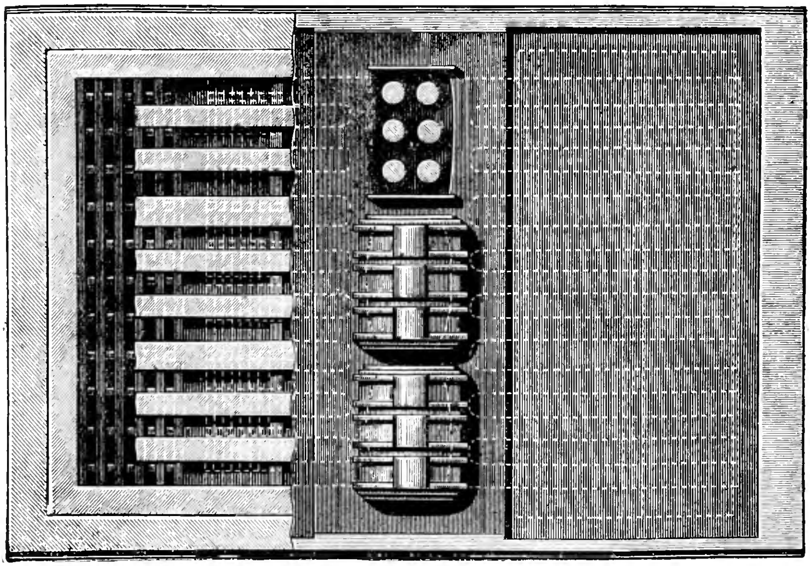

Fig. 52.—Plan of Siemens Pot Furnace.

tages of this furnace are sufficiently numerous and important to make its employment compulsory in all well-administered establishments.

In whatever kind of a furnace the steel is fused, as soon as the metal in the "pots" is thoroughly melted they are removed therefrom by a pair of tongs similar to those shown on the "pot" at the right hand of Fig. 53, and the "teemer" then grasps the "pot" with another pair of tongs and "teems" (pours) the fluid steel into an ingot mold of cast iron, care being taken that the stream of metal passes down the center of the mold without coming in contact with its sides.

The heat of the whole operation of "pulling out" the "pots" and "teeming" the steel (which last is well represented in Fig. 53) is so great that the workmen envelop their limbs in thoroughly soaked woolen cloths (technically called "rags"), which require wetting repeatedly during the casting of a "heat" of steel.

When the manufacture of cast steel was first undertaken in

England, the "ingots" of steel were drawn into bars of various sizes and shapes, under quick-working "tilt-hammers," and this operation was called "tilting the steel"; the "tilter" sat in a suspended seat, and moved his body to and from the anvil by his feet, while his eyes were fully occupied in watching the size and form of the bar, and his hands in turning it upon the anvil. The English machinery and practice were copied in this country, in the

Fig. 53.—"Teeming" an Ingot of Steel.

early steel works, and a plant of steel "tilting-hammers" is shown in Fig. 54. No small part of the expense of maintaining such a plant was the cost of timber for the wooden "helves" of the hammers, which, notwithstanding the heavy bands of iron encompassing them, required frequent renewal, owing to the shattering effect of the heavy and constantly repeated blows to which they were subjected. At the present time all "cast steel" is drawn under steam hammers, whose construction is a modified form of that invented by Nasmyth, already described.

The first step toward the production of steel in such large masses as were required for cannon, armor-plate, the shafts of ocean steamers, and parts of steam-engines of the largest class, was the making of steel by a modification of the puddling process, whence the new product was called "puddled steel." The operation consisted in using a superior quality of charcoal pig iron, and in so manipulating it that the carbon was only partly removed; and the resulting product was a weldable and forgeable metal, possessing many of the qualities of the softer varieties of steel. The art of puddling steel is of German origin. The first efforts to practice it are said to have been made at Frantschach, by Schlegel and Müller, in 1835. This and several other attempts failed, and "it was not until 1850 that good puddled steel was produced in the iron-works of Messrs. Lehrkind, Fakenroth & Co., at Haspe, by following the suggestions of the chemist Lahaye."*

The process was introduced into England in 1850 by Ewald

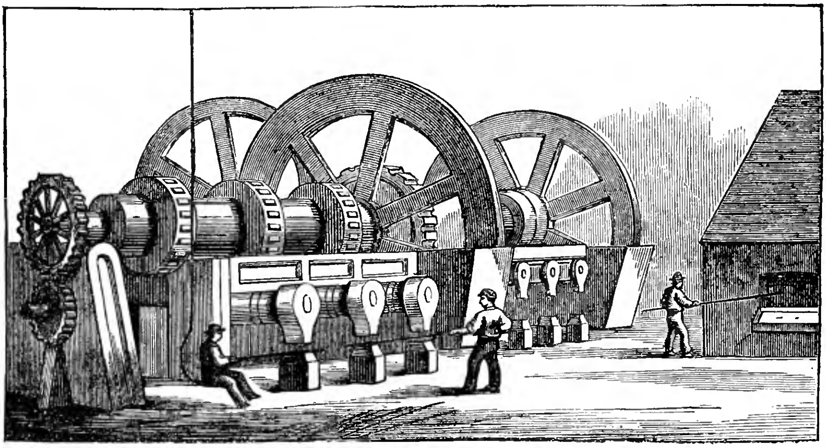

Fig. 54.—Old Style of Steel "Tilting-Hammers."

Reipe, and hence became known there as the "Reipe process"; it was patented in 1859 in the United States by Anton Lohage, and was operated for a time by Messrs. Corning & Winslow, of Troy, N. Y., and by Messrs. James, Horner & Co., at Pompton, N. J. In 1870 there were eleven hundred and eighty-five tons of "puddled steel" made in this country, valued at $218,500; but before the year 1880 the process appears to have become obsolete in America. By their neglect of this process the owners of American iron and steel works threw away what would have been to many of them a source of great profit during the twenty years preceding the introduction of the "Bessemer" and "open-hearth" processes of manufacturing steel. In Europe, however, during the past forty years, a very large amount of steel has been made in this way,

* Practical Treatise on Metallurgy, by Crookes and Röhrig.

much of it for remelting in pots, and a great deal being used for forgings. In the "Centennial Exhibition of 1876" there was shown in the Swedish department by the "Motala Iron and Steel Works" a number of welded coils of "puddled steel" intended for "gun-hoops" and several finished "hoops."

The introduction of the "Bessemer process" into the United States preceded by a few years that of the "open-hearth," but their advent was practically coincident. For convenience, the latter will be described first. By this process pig iron of a suitable quality is melted on the hearth of a reverberatory furnace, and then either wrought-iron "scrap" or iron ore is mixed therewith.

The principle of the "open-hearth" process was well understood by metallurgists for many years before it could be carried into practice, owing to the impossibility of securing a sufficiently intense and continuous heat in any ordinary form of reverberatory furnace. As early as 1824, M. Bréant * stated that "it would be possible to produce cast steel on a very large scale in reverberatory furnaces by following a process analogous to that of the depuration of bell-metal—that is to say, by adding to the metal in fusion [pig iron] a portion of the same metal oxidized, or, still better, natural oxide of iron." In 1845 Josiah Marshal Heath (who invented the use of manganese in melting steel in pots) patented a method of making steel in large quantities by melting cast and wrought iron together upon the open hearth of a reverberatory furnace; and, for the purpose of preventing the contamination of the metal by the ashes of solid fuel, he designed to heat his furnace by jets of gas. But the experiments of Heath, although pointing out clearly the road to success, were not themselves successful. M. Alfred Sudre patented in England, December 31, 1858, a method of melting steel in a reverberatory furnace. He made experiments in 1860 and 1861 near Paris, the expense of which was defrayed by the Emperor of the French, but they fell short of a commercial success. It was not until 1864—forty years after the original suggestion of M. Bréant—that the making of steel by the fusion of pig iron and wrought-iron "scrap" on the open hearth of a gas-fired reverberatory furnace could be regarded as commercially and technically successful. This result was attained by a combination of the "regenerative gas furnace," then recently invented, with the perseverance and technical skill of Messrs. Émile and Pierre Martin, who, notwithstanding its failure in other places, erected one of the Siemens furnaces in their works at Sireuil, France. Evidently there was a lurking doubt in the minds of the Messrs. Martin, for this furnace seems to have been so constructed that, if it failed as a melting, it would succeed as a heat-

* Annales de Mines, 1824.

ing furnace.* Nevertheless, they succeeded in producing in it cast steel of excellent quality, of a variety of tempers, for which they were awarded a gold medal at the French Exhibition of 1867.

The success of the Messrs. Martin, together with the fact that patents had been granted them for certain details of manipulation, brought about a combination of the interests of the Messrs. Siemens and Martin in the process, which has come to be known as the "Siemens-Martin open-hearth process." The construction of a small furnace for conducting this process is illustrated by Figs. 55 and 56—the first being an elevation showing the "ingot molds" arranged in order upon a traveling carriage, *k*, by which they are successively brought under the "tapping spout," *b*, to

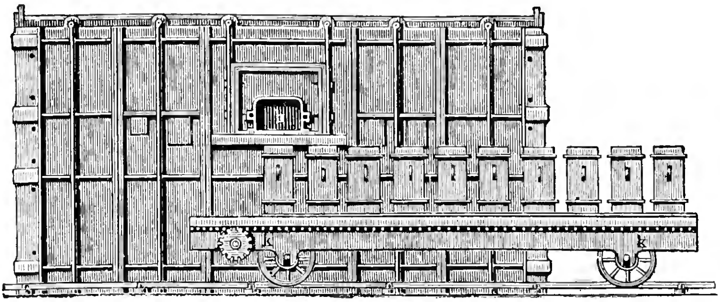

Fig. 55.—Elevation of an Open-hearth Furnace.

be filled. Fig. 56 is a vertical cross-section, taken through the "charging door," *a*, and the "tapping spout," *b*, of the same furnace. Beneath the melting chamber will be seen the "regenerative checker-work," C, C, whose function and operation are the same as in the "pot melting furnace" already described.

The earlier "open-hearth" furnaces were like that illustrated, quite small, making but two or three tons of metal; but at the present time there are a number in operation of upward of twenty tons capacity, equipped with much more perfect apparatus for casting ingots than that shown in the engraving.

To the Hon. Abram S. Hewitt is due the credit of introducing the "Siemens-Martin" "pig and scrap" process into this country. While serving as one of the United States commissioners to the Paris Exposition of 1867, he became favorably impressed with the merits of the process, and sent Frederick J. Slade to Sireuil

* In this connection we are reminded of a hunter, who, on his weary way home without game after a hard day's tramp, thought he saw through the gathering mists of evening a deer entangled in a thicket; but, as he raised his gun, his companion suggested that it might be a calf. "All right," said the hunter, "I'm going to aim so as to kill it if it's a deer and miss it if it's a calf." A great many guns have been so aimed by hunters for metallurgical "game," but it is quite safe to say that they oftener killed the "calf" than the "deer."

to study it in detail. In 1868 Mr. Slade built for Cooper, Hewitt & Co., at Trenton, the first "open-hearth" furnace constructed in America, which was put in operation in December of that year. The process made slow progress for several years, and we find that in 1874 there were but 7,000 net tons* of steel made in that way in the whole country; but from year to year the manufacture has increased, until in the census year ending June 30, 1880, there was reported 84,302 net tons, which we find augmented to 504,351 net tons for the census year ending June 30, 1890.†

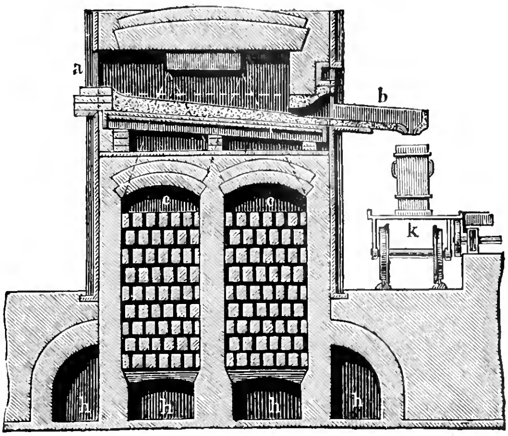

FIG. 56.—VERTICAL CROSS-SECTION OF AN OPEN-HEARTH FURNACE.

Within recent years there have been several efforts to produce "direct from the ore" "blooms" or "muck-bar" for use instead of "wrought scrap" in the open-hearth furnace, some of which give promise of success under favorable conditions of location, ore, and fuel. There have also been several attempts to make what has been very properly called "iron sponge"‡ for use in the "open hearth." Of the details of some of these it can be said that whatever was new was not good and all that was good was not new. However, it is not improbable that a good way of making "iron sponge" will yet be devised, and there are some encouraging experiments even now in progress. In the past twenty years variously contrived rotating furnaces have been invented to produce "blooms," in which for the severe manual labor of puddling was substituted a mechanical movement of the furnace itself. Some of these contrivances have had an ephemeral success, but none have won a place among generally approved apparatus.

THE BESSEMER PROCESS.

No improvement in practical metallurgy since the time of Tubal-Cain has realized such magnificent results in increasing the quantity produced and diminishing the selling price of a metal

* Swank's Annual Statistical Report of the American Iron and Steel Association for 1889.

† Census Bulletin, No. 13, Production of Steel. Report of Special Agent Dr. William M. Sweet to Robert P. Porter, Superintendent of Census.

‡ This is made from a rich iron ore by depriving it of its oxygen, leaving the metallic

as that which is known world-wide as the "Bessemer process" of manufacturing steel. In general terms the "Bessemer process" may be described as the art of decarburizing molten cast iron by blowing streams of atmospheric air into and through it.

For over three quarters of a century the germ of this wonderful process lay dormant in the "refinery fire," * awaiting the time when the needs of man should call it forth. It will be remembered that the decarburization of the molten iron in the hearth of the "refinery fire" was accomplished slowly and imperfectly by blowing air upon its surface beneath a large mass of fuel whose presence was believed to be absolutely necessary in order to maintain the heat of the metal under treatment. Had those early refiners blown the air *into* the metal, they would have been astonished to find that its temperature increased rather than diminished; that the refining operation was very much shortened; and that, if the blowing was continued for a short time longer than was necessary to make refined cast iron, the metal would become malleable—in short, they would have discovered what is now called the "Bessemer process."

Success is always perilously near to failure. All great inventions and discoveries have usually more than one claimant, and this revolutionary process is no exception to the rule—a rule which is so universal that it almost justifies the belief that when in the fullness of time the world is prepared for a decisive advance in the sciences or the arts, an overruling power indicates simultaneously to minds separated oftentimes by continents and oceans some way to satisfy the growing needs of the world, and all to whom such revelations are given, who contribute to their promulgation and success, are entitled to an honorable recognition and reward commensurate with the value of their services to mankind. The first mention of an attempt to improve the refining of molten cast iron by the action of air introduced below its surface is in an English patent granted September 15, 1855, to Joseph G. Martien, of Newark, N. J., then residing in London.† The general nature of Martien's process is thus stated in the specifications of his patent. "In carrying out my invention, in place of allowing the melted iron from a blast-furnace simply to flow in the ordinary gutter or channel to the bed or molds, or to refinery or puddling furnaces in the ordinary manner, I employ channels or gutters so arranged that numerous streams of air, or of steam, or vapor of water may be passed through and among the melted metal as it flows from a blast-furnace."

iron as a porous, spongy mass which can be put directly into the bath of an open-hearth furnace, or be balled up in a reverberatory furnace and rolled into "muck-bar."

* Illustrated on page 328 of vol. xxxviii.

† This patent was purchased by the Ebbw Vale Iron Company soon after it was issued.

In commenting upon this patent the late Dr. Percy very truthfully says:* "It is perfectly clear from the specification that the patentee did not propose to effect by his process the conversion of pig iron, whether unrefined or refined, either into steel or malleable iron; and it is equally clear that he simply intended it to be employed as accessory to the ordinary process or processes in common use for effecting the conversion of pig iron into malleable iron. . . . The patentee emits not the slightest hint to show that he was aware of the fact that by blowing atmospheric air through molten pig iron sufficient heat would be developed to keep it in a state of liquidity, even for a very short time. Air and steam are spoken of precisely as though they were similar agents, and would produce similar effects, whereas their effects would be radically dissimilar. . . . However, in October or November, 1855, that is, two or three months prior to the publication of Bessemer's first patent, in which he first announced that he could perfectly decarburize molten pig iron by blowing air through it without the further application of external heat, the following remarkable experiment was proposed and conducted by Mr. George Parry, of the Ebbw Vale Iron Works: . . . 'In the bed of a reverberatory furnace several wrought-iron pipes, about one inch in diameter, were laid parallel to each other and about three inches apart, in the direction of the long axis of the furnace. The pipes were all put in connection with the blast apparatus. Their upper surfaces were perforated with holes about three inches apart, of which there were about eighty or one hundred altogether; and wires having been first stuck in these holes, the pipes were covered solidly over with fire-clay. When the clay bottom, thus formed, had become dry, the wires were pulled out. The furnace was very gradually heated, and then about 1½ tons of pig iron from No. 1 blast-furnace at the Victoria Works was run in, the blast having been *previously* let into the pipe. Vigorous action occurred, when, by some mishap, the molten metal escaped from the furnace into the road. The then managing director of the works was unwilling that the experiment should be repeated, and the furnace was dismantled, happily for Bessemer.'"

On October 17, 1855, Henry Bessemer (now Sir Henry Bessemer) was granted his first English patent for "improvements in the manufacture of cast steel"; other patents for improved methods and apparatus followed in rapid succession; and at the meeting of the British Association at Cheltenham in the early part of August, 1856, Mr. Bessemer read a paper before its Mechanical Section On the Manufacture of Iron and Steel without Fuel.

* Percy's Metallurgy, Iron and Steel, London, 1864.

"This paper," says Percy, "excited much attention, and was the first really public announcement of the invention." It was read in America with great interest; and it has recently become publicly known that under its stimulus the Hon. Abram S. Hewitt caused an experimental converter to be erected at the furnaces of Messrs. Cooper & Hewitt, at Phillipsburg, N. J. To an inquiry from me regarding this converter Mr. Hewitt has very courteously replied as follows:

New York, *February 13, 1891.*

W. F. Durfee, Esq., *Birdsboro, Berks County, Pa.*

Dear Sir: In reply to your letter of the 11th instant, I cheerfully furnish the very meager description which is necessary to enable you to describe the introduction of the Bessemer process, so far as Cooper & Hewitt are concerned, in this country. On reading the paper of Mr. Bessemer, delivered at Cheltenham, I directed that an apparatus should be prepared at our works at Phillipsburg, N. J. The idea had been to use the ordinary blast from the furnace engines, which at the time were blowing about five pounds to the inch. I can not give you any drawing of the converter, but it was built according to the description contained in the Cheltenham paper. The capacity was about one ton. Before the apparatus was tried, Mr. Cooper went to Europe, where he ascertained that the Bessemer invention was a total failure, because the material produced was unfit for use. On receipt of this information, we suspended all further efforts to produce steel by the direct process, and, as a matter of fact, it now turns out that no steel was ever made in this experimental apparatus. So far as I know, therefore, the first actual steel made in this country by the Bessemer process was produced at Wyandotte; and, in ignorance of the fact that our apparatus was really never put in operation, I think I made a larger claim than would be justified by the facts; but you will remember that what I said was not intended to set up any claim for priority, but only to establish the fact that we were very hospitable to new ideas in the development of the steel business. Sincerely yours,

(Signed) Abram S. Hewitt.

This very frank letter is confirmatory of the fact (until recently undisputed) that "the first actual steel made in this country by the Bessemer process was produced at Wyandotte" more than eight years after Mr. Bessemer read his paper at Cheltenham. In 1856 Mr. Bessemer obtained two patents in the United States for his improved method of making steel; "but," says Swank, "was immediately confronted by a claim of priority preferred by William Kelly, an iron-master of Eddyville, Ky., but a native of Pittsburg, Pa."

Before speaking further of the relative claims of Bessemer and Kelly, we will explain as fully as space will permit the apparatus invented by the former, which, with slight modifications, is used wherever Bessemer steel is manufactured. The vessel in which the melted pig iron, or iron taken in a molten state directly from the blast-furnace, is transmuted into steel, is called a "converter." Fig. 57 is a vertical section of an early form of one of these vessels, which are made of heavy plate iron, and provided with a very thick lining of the best fire-resisting material. At the bottom of the converter is a chamber called a "*tuyère*-box," from which a number of "*tuyères*" made of baked fire-clay pass upward through the lining of the vessel.

The "converter" is hung upon "trunnions" (much as cannon are), through one of which the blast is conveyed to the "*tuyère*-box"; these trunnions rest in "bearings" which, in some of the earlier converters, were on the top of tall iron stands (the base of one of such stands is seen in Fig. 57) firmly bolted to foundations of masonry; but in more modern constructions these bearings are supported by iron girders sustained by columns, or masonry piers are carried up of sufficient height to receive them. The air blast being carried through the hollow trunnion permits the turning of the vessel upon its bearings without interrupting the blast by so doing; this turning is in modern practice generally effected by some adaptation of hydraulic machinery, and occasionally by "worm" or "spur" gearing as shown in Fig. 58. The pressure of blast used was at first four to five pounds, but this was soon increased to eight, and, although there are still a few converters blown at this pressure, in the larger establishments a blast of twenty to twenty-five pounds is usually employed. Why such pressures are used, involving very heavy and expensive machinery and an excessive amount of power, is not evident, as no better or cheaper steel can be made thereby.

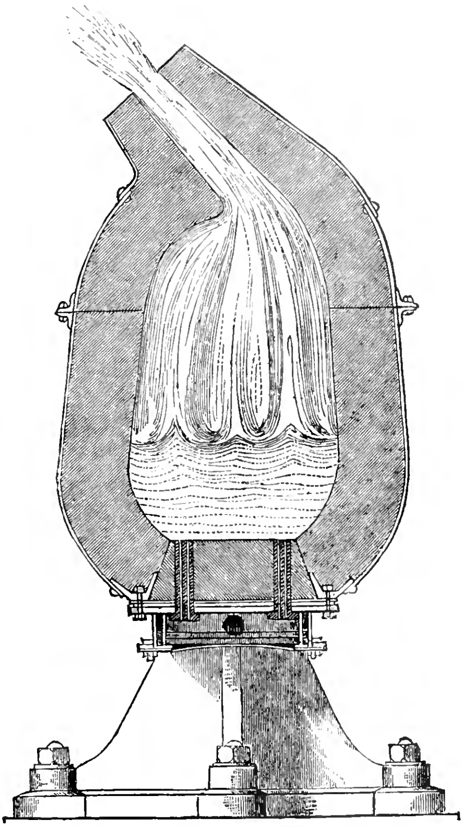

FIG. 57.—SECTION OF A BESSEMER CONVERTER.

The operations for making steel are as follows: The converter, after having been newly lined, is thoroughly heated by means of a coke fire built therein, and urged by a blast through the *tuyères;* when the lining is sufficiently hot, the converter is emptied, sufficient blast being used to blow out all the dust, etc. The vessel is then turned with its body nearly horizontal, and the charge of melted iron is run in at its mouth.* The vessel is next turned so that its body becomes erect (as in Fig. 57), and, as soon as this turning commences, the blast is put on. An enormous discharge of particles of burning iron escapes from the vessel's mouth as it moves toward an erect position, and when the turning ceases it is evident that a most intense reaction is taking place between the oxygen of the air blown into the "converter" and the silicon and carbon contained in the iron. The mechanical action of the blast in throwing about the liquid metal augments the internal tumult—intense flame issues with an angry roar from the converter's mouth, and the whole apparatus trembles as though it was possessed of a devil that was reluctant to be cast out.

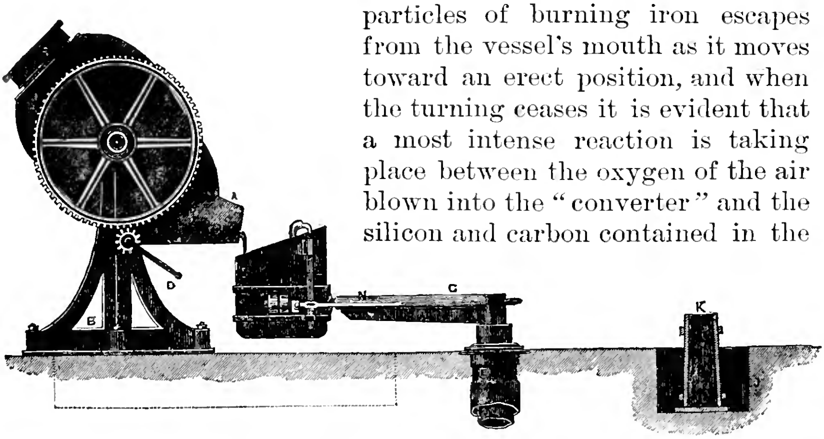

Fig. 58.—Pouring Steel from a Converter.

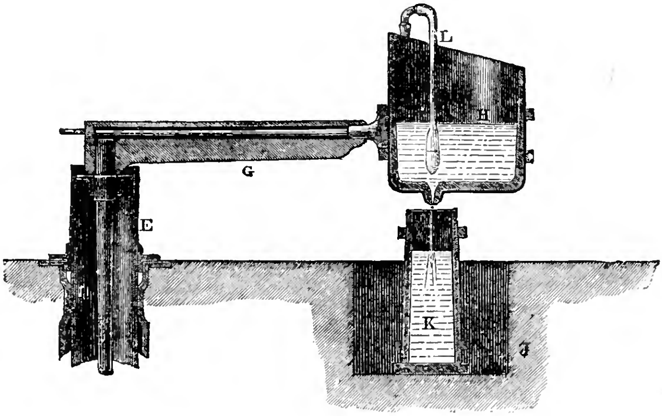

Fig. 59.—Casting Ladle and Mold.

After the lapse of a certain time (varying with the character and quantity of the metal being operated upon), the flame at the mouth of the converter undergoes a great reduction in volume and change in character, and it is by the appearance of this flame

* The early "converters" had a capacity of from one to three tons, but we now hear of "vessels" holding from fifteen to twenty tons.

at this critical period of the process that the person in charge of the operation judges of the proper time to "turn down" the "vessel" and cut off the blast. When that time arrives, the vessel is turned with its body in a horizontal position, and a certain weight of a metal called *spiegeleisen* is added in a molten state, and the converter is then turned still farther down into the position shown in Fig. 58, and its contents poured into a casting ladle H, attached to the end of the arm of a crane, G. This ladle is provided with a "tap-hole" in its bottom, which can be closed by a valve attached to the lower end of the spindle L (Fig. 59). Of course, the interior of the ladle as well as the valve and its spindle are made of the best fire-resisting material obtainable. The spindle L is raised or lowered to open or close the "tap-hole" by means of a lever, N (Fig. 58), which operates a vertical slide-bar to the upper end of which the spindle L is attached. The crane-arm G is attached to the upper end of a cylindrical ram or post capable of moving upward as well as rotating in a hydraulic cylinder, E. The ingot molds (of which one is shown at K) are placed in a circle, whose center is that of the cylinder E, and are filled in succession by swinging the crane about the same center. The molds K are made of cast iron, and are smaller at the top than at the bottom, in order that they may be readily "stripped" off the ingots of steel.

The apparatus shown in the above-described figures was the invention of Henry (now Sir Henry) Bessemer. It is remarkable for its ingenuity and perfect adaptation to the needs of the new process, and, notwithstanding the lapse of over thirty years and the accumulated experience of multitudes of metallurgists and engineers, substantially the same apparatus is to-day in use in every Bessemer steel-works in the world. Of course, there have been many changes and some improvements in details, but its essential features remain as they were planned by their inventor thirty-six years ago—the converters still turn on their trunnions and receive their air-blast as has been described; the casting-ladle continues to be attached to a hydraulic crane and to discharge its contents through a valve-closed "tap-hole" in its bottom; hydraulic cranes are still used to rapidly handle ingots and molds; and these foundation facts of ingenious design promise to continue in use for all time as enduring evidences of great originality in the selection and adaptation of means to ends, and fairly entitle their inventor to a foremost place among the mechanicians of the century.

[*To be continued.*]

METAMORPHOSES IN EDUCATION.

By Professor A. E. DOLBEAR.

INSTITUTIONS are necessary for society of all grades. The Hottentot needs them as well as we and has them. In society that has been stable for a long time the institutions have been so adjusted that they are very perfectly adapted to the needs of the people, as those in China are. In a community where nothing new is learned and nothing forgotten, the mechanism for the maintenance of society runs with the least friction, and in a good sense the institutions of a country are the mechanical supports which maintain its form and give coherence to it. When one thinks of an Englishman, a German, a Russian, or a Turk, he is not thinking of one who chances to speak this or that tongue or who has this or that cast of countenance, but of one who has been molded by certain institutions in which he was brought up, and which have given to each one a personality different from any of the others, which personality has adapted him to live comfortably with an environment different from the others, and in which each of the others would find more or less that was disagreeable, and in which, at any rate for a time, he would be uncomfortable. This fitting a man for his environment is education in the large sense, and every human being is educated thus. The great difference between both individuals and nations is traceable to the breadth of the environment or the number and variety of institutions that are operative in their growth.

Wherein is the difference between the German and the Turk, that one is a synonym for civilization while the other is a symbol of barbarism and lethargy? One has been educated not only by his own institutions but by all other available ones; he has laid the world under tribute and the heavens bring to him comforts, while the other with as good opportunities has been for centuries content to shut out from himself all foreign influences whatever. His environment has been simply that of his own involuntary efforts, and it has made him a beast, as it will any who are content with less than the universe can give.

This environment of which I speak is not one of locality merely, and does not imply that the one who has traveled most is the best educated. The mountain does go to Mohammed if Mohammed commands it aright. Through literature and science all institutions are available for the one who wants them. That is a very poor education that fits a man to be a citizen content with a dozen neighbors who all do and think as he does. That is the highest and best education that fits one to be an inhabitant of the world—a cosmopolitan who feels the Englishman or the German or the Russian to be his neighbor as much as the man who lives across the way—and if there can be a higher one still, it is that one who, if physical boundaries allowed, could traverse space and find comradeship and attractive society in Mars or the milky way.

Environment is mental as well as physical, and it too has a natural history, and in a given individual the limits of his possibilities are determined for him and not by him. This has been the result of stable institutions in the past upon successive generations, and is exemplified in the history of every people that has been subject to them. From this one may learn either that stable institutions are not desirable, or rather they are to be dreaded and fought against, or else that such stable institutions as history can show are not adapted to humanity if mankind is to have any worthy future. During the two or three centuries embracing the best days of ancient Greece, as looked at from this distance, not only was she troubled with hostility from without and with jealousies within, but nearly every individual, from the greatest to the least of them, was addicted to the grossest immoralities, which we have been and are still taught were not only scandalous and not to be tolerated, but that they are fatal to the existence of society, and so must not be tolerated. Yet Greece was not killed by its bad habits.

Since the time of the revival of learning, all those people that were subject to it sought for other influences than those of their own time and nationality to react upon them. *Each one had a barbarian for a neighbor*, but in the literature of Greece and Rome they had illustrious examples of men molded in other ways and by different methods, and these became in a measure the ideals toward which mankind should strive. The proper study of mankind was man, but the man studied should be a worthy one. The Catholic bishop declared that all the saints were dead. Inquire in any neighborhood for the wise man, and you will be told that he lives in another town. The ancient glory that could be read about was available for those who aspired for knowledge, and it soon came about that Socrates and Plato and Aristotle, Cicero and Demosthenes, Horace and Lucretius, Xenophon, Herodotus, and the rest became the teachers of western Europe. For most students and teachers it still holds true that a well-edited man, though he has been dead a thousand years, is preferable to an unedited living man, however eminent he may be. It is a great saving of time and of the risk of oversight to the schoolmaster to have the beauties, the grace, the appositeness, the truth, in an author's works pointed out by another. Until men can get along without models it is well that they choose good ones. Phidias, Michael Angelo, Mozart, and the rest of the masters never needed them and would have wasted their time in studying them.

When educational institutions are being founded and a curriculum organized, men will and must take the best material to be had. With such data the educational scheme of the old universities was organized and it became assimilated with the religious institutions already present, and out of them grew a philosophy of education which was theological at its base. Man was a fallen being; he had originally been perfect and upright. He was not an integral part of the universe and necessarily related to it, but was a new creation, endowed in a supernatural way, but who had, unfortunately for him, lost a part of his original patrimony. If he was to better his condition his efforts must be directed to making himself like the best models of men who had lived, which could be done by becoming acquainted with their works and imitating them as closely as possible. The ideal man was the man of the past, and nothing of great importance to character was to be learned by giving attention to things not directly related to humanity. It might be convenient to know something of other matters, but it was not essential to the attainment of character or needed for the ideally perfect man. The so-called humanities consisted of a series of studies into the things that had interested the men of the past, to the end that men might become great and learned and wise and eloquent and good. In that way men could, in a degree, recover their lost estate while in this life, and be fully redeemed in the life to come.

The educational institutions became strong allies of the religious institutions, but the former were subservient to the latter. Any man who attempted to teach differently or who taught matters that were plainly at variance with such principles, though only by implication, met instant hostility from both, and the history of the times is the history of martyrdom.

Vested interests are essential to institutions of any sort and serve as their protectors. Although we can not see how it could be otherwise, yet because of it hundreds of thousands of the choicest of the race have been tortured and have perished in dungeons and in fire.

About two hundred years ago Newton published his Principia. It dealt with physical forces and their laws. It was what we would call to-day a treatise on mechanics. He discovered and formulated the laws, and, after no great contentions, they were quite generally adopted and taught as a branch of learning which it was useful to know. As it was mathematical in its character, it was of a sort that compels assent by the one who understands it; but it was adopted for what it then appeared to be, not for what was necessarily implied in its acceptance. The implications of which I speak were not perceived until long afterward, and had these been seen by Newton or by his contemporaries, and had they been pointed out, the probabilities are that Newton himself would have joined the great band of martyrs for truth that had preceded him. It is now seen that the whole doctrine of what we call the conservation of energy is involved and implied in his laws of motion. If that had been seen in Newton's day it would have been interpreted as an attempt by Newton to dethrone the Almighty by a mathematical process, as such work has been so often stigmatized within the last hundred years. Happily, we live in the post-martyr age, and we have no fears for our lives. But while the laws of mechanism had been accepted and taught for a hundred and fifty years, they were taught mostly as abstract propositions or as applicable to appreciable motions of inanimate matter, not at all as applicable to such a problem as the formation of the earth and of the solar system. So, when Laplace developed the nebular theory on the basis of Newton's laws, the attempt was denounced as impious and tending to overthrow all religious teachings; but the multiplication table holds good, no matter who denounces it or for what purpose; and now, after the lapse of three quarters of a century, men have become able to contemplate the nebular theory without danger of vertigo, and the proposition that the solar system has been evolved from a nebulous mass through the operations of simple mechanical laws is held by all astronomers and others capable of rational effort. When it was perceived that energy existed in several forms, and that these were transformable into each other and stood in quantitative relations to each other, another mechanical step was taken, for the chemistry and geology of the earth were brought under physical laws and relationships, but it was still held that all this could be granted as applicable to inorganic matter, without trenching at all upon the idea that life, and especially mankind, held divine prerogatives, and were not to be included as a part of the general scheme of the development of the earth. The educational institutions were hostile to these various advances, and decided that if true they were premature and not proved, even long after they were accepted by those competent to judge; but, so long as life and humanity were not involved in the problem, they did not need to feel much concern. And wherever, in any college or university in the land, the above advances in physical science were taught or mentioned, it was always with the carefully added statement that it was all outside of humanity, its interests, its hopes, or its fears, and that the statements made by other persons who taught differently in scientific matters were untrue, and were instigated by hatred to Christian beliefs and the institutions founded and maintained by them. Now there have been skeptics in all ages and upon all matters, some giving reasons and some not. Everybody is a philosopher, whether he knows it or not, and consciously or unconsciously makes every new fact or experience fit into his theory of things; it must be explained in accordance with the principles recognized by him and supposed to be known. Experience of mankind and the tricks of jugglers have made it easy to believe that all phenomena may be explained by personal agency of some sort, and to most persons that water should run down hill is no more of a surprise or mystery than that a juggler should be able to take four dozen eggs out of a borrowed hat, while to the physicist the first is an unaccountable phenomenon. It is this easy philosophy that gives so great a following to spiritualism. It is so much easier to understand than physical laws and movements, and is in such complete accordance with human experience of the lowest grade, that it is easier to imagine an immaterial personality that can be summoned to tip tables and rap on the floor, than it is to understand how the laws of energy must be recognized and can not be infracted.

Educational institutions as well as all others were founded upon a philosophy of things that presumed that the human mind was not necessarily related to anything in the world; that therefore its training could be best provided for by supplying ideal standards of excellence in those matters considered of most importance; these were studied chiefly for their gymnastic effects, and therefore best fitting a man for any career, but more especially a professor, a minister, a lawyer, or a doctor. It was true that many men attained to the highest eminence without the slightest aid from such institutions and without any of the gymnastic culture, but the argument was that they would have been better and have done more if they had had it, that it would have saved them valuable time. Inasmuch as the evidence goes to show that those who achieve success without such aids in this way do as much as an equal number educated the other way, it is plain that there is something wrong in the premises.

The world has been often surprised within the past two or three hundred years, but it generally takes a generation or two to discover the occasion of the surprise. The world is now aware of its surprise at the geological theory of the earth, of its surprise at the nebular theory, and at the Copernican theory.

The year 1859 was the year for another surprise, and it is just beginning to be perceived how great was the occasion for surprise. To be sure, the announcement of the theory of natural selection and that of the survival of the fittest aroused instant hostility, and bitter attacks were made upon it for a long time—all without the slightest effect in staying the acceptance of it. The surprise consists in the discovery by the world in general that it is true. Through enormous labors during the past thirty years the science of biology has covered the ground once supposed to be peculiarly the domain of mind, and the natural history of man, both body and mind, are so well known in their most general features that the biologists of every country are agreed that man is an evolved animal, that his lineage can be traced back into the geologic past and to an animal pedigree. In mind and body he has an ancestry reaching into time indefinitely remote, and those who hate to believe it are silenced by the evidence and no longer strive against it. Their only hope is to show reasonable grounds for the belief that Nature has in some way and at some time been supplemented, and that man has some arbitrary mental gifts that can not be deduced from his natural history. This acquired knowledge of the natural history of man has revolutionized every former conception of him, and has rendered worthless—absolutely worthless—almost everything that has been written. Not only physical science, but especially history, philosophy, psychology, ethics—all had to be rewritten, and all *educational institutions founded upon these, as most all have been,* have got to be metamorphosed to adapt them to the knowledge which has been acquired in this century and mostly within the last half of it. The case is precisely similar to the history of astronomy. After the Copernican theory was found to be the true theory, the overthrow of the Ptolemaic was complete. There could be no compromise between the two: if one was right the other was absolutely and irredeemably wrong, and there was nothing but complete surrender to the Copernican theory by every one who had any knowledge of the Ptolemaic system. It had to be complete and unconditional. The teachers of the Copernican theory may have been wrong in many of their statements concerning planetary matters, and some of the Ptolemaics may have been able to point out such errors, but such failures did not give any countenance to the Ptolemaic theory; they only showed that the details of the new science needed more careful investigation. The whole of astronomy had to be rewritten; the only things of any value that had been recorded were that an eclipse occurred on such a day at such a place, or a comet was seen, or an occultation, but the reasonings and deductions by the observers were of no account.

So in like manner, if evolution be true, it follows that all previous philosophizing upon history, philosophy, education, or science, is of no more account than the reasonings of the Ptolemaics. And one to-day will not be advancing himself in knowledge by perusing the volumes of the pre-evolution age. They can not help him, no matter how ably they are written. Nor does it follow that because objectors are able to point to errors in the works of those who are doing their best to interpret Nature on this basis, that the views of the objectors are more tenable, though there are too many who for some reason imagine that, if an author can be found to be in error in some point, his fundamental principles are not trustworthy. That would be as if Kepler should condemn the Copernican system when he found that the planets move in elliptical orbits instead of circular ones, as was assumed by Copernicus, and should say that Copernicus "would talk pretentiously about matters that he knew nothing about."

The astronomer pays no more attention to old theories of his science than he does to astrology. He even says of Kant's presentation of the nebular theory that he gives no reason for it that an astronomer is bound to respect. No chemist to-day needs to know or care what anybody thought about chemistry before Dalton. No physicist to-day needs to know or care what any one thought of electricity before Faraday. Even Franklin's opinion carries no weight. In heat Rumford and Davy are the first whose opinions have any value. In biology nobody appeals to Cuvier or Agassiz. Psychology was revolutionized by the publication of Mr. Spencer's works in 1855; and the other day Ferrier was honored in England for his work in the localization of mental faculties. The new sciences of ethnology and comparitive philology have also revolutionized all notions as to the history of mankind. Histories of the past, written within the last fifty years, are of no more account than the stories of Herodotus and Diodorus about the Egyptians and Assyrians.

About twenty-five years ago Lenormant, the French historian, announced as nearly ready for publication a history of India. In 1870 he notified the public that he had abandoned the work, having made the discovery that most of the data he had collected were worthless and that it was impossible to get anything that was trustworthy. Henshaw, of the Anthropological Society of Washington, declares that the languages of the Indians of this country, of which there were fifty-eight linguistic families and three hundred dialects, north of Mexico, at the time of the discovery of America, are none of them related in any way to Asiatic tongues; also, as to the origin of the Indian, it must have been in ages so far removed from our own time that the interval is to be reckoned, not in years of chronology, but by the epoch of geologic time.

Again, what shall we think on religious matters when a man like Le Conte states that we are on the verge of a profound and radical change in the basis of Christian beliefs; when Rev. Dr. Martineau, whose life has been spent in the defense of historic Christianity, concludes as the result of his best endeavors to discover the truth, and whose hopes and wishes and expectations were all in its favor, that the Christ of the Church is unhistorical; when a man like Clifford says he parted with Christian beliefs "with such searching trouble as only cradle faiths can cause"; when a historian like ex-President White, of Cornell, declares that the anthropologists have destroyed the whole theological theory of the fall of man!

The significance of all this lies here. Our institutions of learning were all founded upon theories of life, of mind, of society, of history, which have broken down. There is not a single one that has stood the test of modern science, and disintegration set in some time back. It came first in a demand that colleges should furnish a knowledge of matters that books and periodicals were teeming with, and for which there was no provision in the curriculum. It came from those who objected to fooling away their time in the study of languages that had proved their unfitness for the needs of mankind, and so had perished from off the face of the earth; who objected to be forced to the study of history that was not true. A sop was offered by some institutions in the shape of scientific courses where instruction was given in the new sciences—physics, chemistry, geology, etc. These, however, were treated in a most unworthy manner by text-books and discourses instead of by practice; second, as if they were topics unrelated to each other, and thus, having no necessary relations to other matters held to be of much greater importance; and, third, the men who pursued them to the exclusion of the old curriculum were snubbed and made to appear as of an inferior grade. Under such circumstances, what should be expected but an educational failure? The institutions, *as institutions*, felt a profound contempt for the new demand, apparently considering it a kind of craze which in a little time would die out, and matters would settle back into the historical ways which time had honored and experience approved. As we now know, nothing of the kind happened, for the very good reason that the old curriculum and the new knowledge were incompatibles. The new knowledge was not and could not be assimilated by the adherents of the old. Amalgamation to any extent was impossible, and compromise was equally impossible, for the new has destroyed the foundations of nearly everything the old held to be true.

What wonder, then, is it to-day that educational institutions show such visible signs of fermentation! Metamorphosis is taking place rapidly. Among schoolmasters one hears a good deal about pedagogy, but the pedagogy is a mongrel, a kind of cross between a theory built upon experience with minds fed on abnormal diet, and a metaphysics as extinct as the dodo. I feel like advising all such to go to Clark University and study psychology.

The pedagogy which is in consonance with the new psychology has not yet been written, and can only be known to one who is well grounded in modern psychology.

At the outset I spoke of education as fitting a man for his environment. Every man ought to know what kind of a universe he is in, what his relations to it are, what and where invariable conditions are imposed, what in the nature of things is possible and what impossible, within what limits all his achievements must be, and hence what ideals he may consistently cherish that his work may not be in vain. It hardly needs to be said that neither literature nor art nor history nor theology can acquaint a man with these. Only science can do it—science not as a mass of facts, but as a body of relations. If there be anything that the ordinary man is markedly deficient in, and which the best schooling has not added to his mental equipment, it is his failure to see the *necessities* of relation. Exercises in logic and the study of mathematics have been supposed to qualify a man to be logical, but if by this is meant that for every effect to be explained an adequate cause must be assigned, then most men are unequal to the occasion. What should be thought of the man who believes that the character of the weather for the next month is determined by the position of the horns of the new moon, or of the supporters of the pretensions of Dr. Gary and of Keely—some of them are not only college-bred but have reputations for business sagacity quite out of proportion to their knowledge of possibilities. Now, the study of mathematics as it is conducted to-day fails to develop a very strong sense of the necessities of mathematical relations, for the reason that most of it is symbolic and the symbols are not translated into experience. On the other hand, geometry is well calculated to induce in one an unshakable belief in such necessities; but this subject is neglected, while algebra and other symbolic processes engross the time and attention to the detriment of the student who goes no further than his prescribed studies. I know of a college president who a few years ago denied the validity of simple arithmetic processes when the numbers rose to millions! Now, most men have beaten into them in their business lives these necessary relations about which I am speaking, so far as their own business is concerned, and there is no trusting to superstitious factors, for superstition is but a belief in an inadequate cause; outside of their business their judgments are untrustworthy. But physics and chemistry, when pursued in the laboratory, present in a tolerably simple form relationships in an invariable and quantitative way, and the student learns by experience that, where certain conditions are, a certain result will follow with rigorous exactitude. Familiarity with facts of this class leaves him with the consciousness that among physical and chemical phenomena, wherever they occur, there is always a quantitative as well as a qualitative relation, so that, given the antecedent, he can determine the consequent, and *vice versa*. Now, the point to this is that it is of application wherever such phenomena occur, that for the past and the future they *must* hold good for the same reason that the multiplication table must hold good. If, however, the student goes not beyond these sciences, he has not learned half his proper lesson. In physics the phenomena are relatively simple. In such sciences as those called natural history the complexity of phenomena becomes very great. Exactitude is not possible to the degree it is in the former studies, and judgments must be formed on different grounds from those. Here there are estimates and probabilities to be considered, and a degree of caution in forming a judgment, not called for in the simpler sciences. There are principles he has got from these physical sciences which he must carry into the more complex studies, viz., that complexity does not impair the certainty that the laws of matter hold true wherever matter is. He is prepared in a good measure to say what can not happen, but not so well prepared to say what may happen. These sciences then act as a check upon hasty deductions; but both of them enforce the idea of continuity, an idea which is very vague in most minds, and is the source of no end of confusion among so-called philosophers.

Again, the science of life contributes to a proper discipline in still other ways. Here one meets with phenomena in which effects are not to be measured by the amount of the acting agent. Consider Koch's consumption-cure: the thousandth of a grain injected into the circulation not only presently brings about great physiological disturbance, but actually locates itself and does its work in diseased tissue in a distant part of the body, yet affects nothing if the body be healthy! Here is a contingent result which is a characteristic of organic phenomena. So to continuity and complexity there is needed a knowledge of contingency in phenomena. By themselves biology and geology, and indeed all the complex sciences, tend to render vague the idea of necessary relations; but when to a knowledge of them is added a knowledge of physics and chemistry, a judgment formed upon an involved question will certainly have much greater weight. Lastly, there is the necessity for a knowledge of psychology. A true understanding of the acts of individuals or communities can not be had without the knowledge of the laws of mind. Every question of a sociologic nature presupposes this as the condition for intelligent action, and it is for the lack of this preparation that all the mistakes in legislation, in schemes for education, for charity, as well as those that men have made in interpreting history, are due.

An adequate knowledge of psychology can not be had without a knowledge of the brain, its functions and relations, and this implies a knowledge of biology, and biology has its foundations in chemistry and physics. I do not think there is any one whose opinion one would care for who disputes these relations, but the necessities of them there are many who do not see; they are those whose ideas of physical relations are misty and unsound.

These are the essential things that every man ought to know whatever else he may know, for they have to do with the every-day life of every man. With them he is best prepared to act wisely in every calling in life, and without them right acting is a hap-hazard affair, as one is likely as not to be at war with the nature of things, even when his intentions are irreproachable. The stars in their courses fought against Sisera, but Nature never begins a contention. When one is initiated, she never asks for the character of the litigant. No distinction is made between ignorance and intention, piety and depravity, and no contention is ever settled by compromise, it is always an unconditional surrender. These are therefore the things that a college should teach, whatever else it might offer. But these are not to be learned from books. They must be got at first hand to be useful. It may be noted that these things are not to be learned so much for the facts presented as for the relations implied, though a true relation is as much a fact as any illustration of it can be. The law of gravitation is as much a fact as water running down hill is, and the continuity of phenomena is of vastly more importance to the race to know than all the mental efforts of the race before the time of Newton. If once accepted it dominates everywhere.

This is the condition of things that confronts us. The past has already been broken from, whether all are conscious of it or not. Its great ones are no longer our teachers and leaders in knowledge. The point of view of human affairs is not only changed, but there is demanded a change in the ideals of the race. Science has given us a new heaven and a new earth. The education of the past has proved not only inadequate, but wholly incompetent to train a mind so that it can assimilate or appreciate genuine knowledge. The names of those who have built up this new body, with few exceptions, can not be found on the registers of the great schools. Does it not appear to the disadvantage of the great schools that the discoveries which have so revolutionized men's ways of thinking and doing were nearly all made by men who had few or no opportunities for school education? To name but a few, think of Watt, of Stephenson, of Dalton, of Faraday, of Joule, of Huxley, of Spencer, of Franklin, of Henry, of Edison. There are no corresponding names to stand beside them for attainments, and the record of the exceptions is mostly for stupidity in the school work, while the opposition and hindrance to the general reception of new truth in any field have always been due to those educated in those schools, which shows that they were not only incompetent judges, but that they had no criterion of truth, and therefore did not recognize it when it was plainly set before them. The end of this is at hand. The old will be transformed. Metamorphosis is easier than creation. The grub has already entered the chrysalis stage, and the process of transition may be heard by the attentive ear. The custodians know that something serious has happened, but they try to console themselves with the hope that the same old grub will appear with all its essential features unchanged, while the observer of processes knows that when it emerges, its former friends will not identify it, for it will be not only different in form but will be adapted to life in another sphere and to be nourished with a different kind of food, and as soon as the sunlit air has dried out its wings it will surely fly from the grounds of its former protectors, unless they shall provide flowers in the place of leaves.

THE RIVALRY OF THE HIGHER SENSES.

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PROBABLY no subject presents to the psychologist and the physiologist a greater number of unexplored regions than that of the senses and the organs of sense. As yet we do not know how many special senses we possess. To the traditional five are now added the muscular sense, about whose organs there is no little dispute; the temperature sense, including separate end-organs for sensations of heat and cold; and the now problematic sense of equilibrium, whose organs are thought to be the semi-circular canals. Still less is known about the senses of animals. Some of these, as has been shown, are sensitive to colors, sounds, tastes, and odors to which the human sensorium does not react. Most interesting are the patient experiments of Sir John Lubbock, proving that the eyes of ants are sensitive to the ultra-violet rays of light. To them, therefore, even "white" light is not white. "The familiar world which surrounds us," says Lubbock, "may be a totally different place to other animals. To them it may be full of music which we can not hear, of color which we can not see, of sensations which we can not conceive." The presence of doubtful sense organs in animals, such as the muciferous canals of fishes, strikingly suggests the limitations of science; for we not only do not understand these organs, but perhaps never can understand them, as such sensations may be outside the range of our possible experience.

Returning to the human body, we find that very little has been said about the relation of the senses to each other, the order of their development in the evolution of the race, or the present tendency of their relative development. The theory proposed by Democritus, that all our senses have been evolved from the sense of touch, seems likely to be established by biological studies. But it may be more accurate to say that all the senses are specialized forms of a primordial sense, which may have been less like our sense of touch than that of sight. In this connection one recalls, and with somewhat less skepticism, certain recent experiments of the French investigators in abnormal psychology, showing that hypnotized subjects see and hear with their finger-tips.* With the growth of intelligence, there has been a steadily increasing use of the two senses which give us the finest discriminations and the widest knowledge of our surroundings, viz., the senses of sight and hearing. When each animal was obliged to search for and select his own food largely by smell and taste, the latter senses were no doubt the best developed. For tones, colors, and form these animals had little care. They thought, as far as they thought at all, in images of taste and smell, as we think in images of sight and hearing. Many animals now are smell-minded, and in the thoughts and dreams of dogs and deer we may suppose that images of odors are as prominent as visual images are in our own. In man the crude organs of taste and smell have given place to the delicate eye and ear, both as avenues of knowledge and as sources of higher pleasures. What is true of taste and smell is true also of touch. Not confusing this with the muscular sense, the information we get from the sense of touch is small and the pleasure less. That this sense is capable of such remarkable improvement in the case of the blind is evidence only of its once greater use.

It is not now my purpose, however, to compare the senses of sight and hearing with the lower senses, but with each other. It is, perhaps, not realized by many that there are certain new conditions in modern life and certain innovations in our system of education that are bringing the eye into unprecedented importance in comparison with the ear and the other organs of sense; that this greater relative use of the sense of sight will result in its greater development, while the lessened use of the sense of hearing will lead to its deterioration. Such a result would not only threaten several noble fine arts connected with the ear, and incidentally weaken the memory, but would also effect an important change in man's personality. I will try to point out the

* See Hystéro-épilepsie masculine: Suggestion, Inhibition, Transposition des Sens. By Prof. Fontan. Revue Philosophique, August, 1887.

prevailing eye-mindedness of our times, together with some of its causes. A moment's observation of our own stream of thought will show us how largely it is made up of visual images. Any one may easily verify for himself what the experience of deaf-mutes has proved, that thought is both possible and common without language, though this has so often been denied. It is quite true that ear-minded people, with small visualizing power, carry on much of their thinking by the symbolic imagery of words. Most people doubtless do their more abstract thinking largely through these convenient media, though Galton suggests that abstract ideas are, after all, only generic images, composite photographs, as it were, of the various individual things of our experience. At any rate, if we examine our own minds we see that what goes on there is, for the most part, a ceaseless flow of images of concrete things, and that of these images the visual ones are in a vast preponderance over those of the other senses. Even the word *image* suggests a visual form, and *imagination* should mean derivatively the reproduction of such forms. In our abnormal mental states—such as dreams or the delirium arising from fever or drugs—our experiences are visions rather than sounds. In our dreams we see much and hear comparatively little, while it is still rarer to dream of tastes and odors. The congenitally blind are, of course, exceptions to this rule, while blind deaf-mutes, like Laura Bridgman, dream in terms of what senses they have, and there are other exceptions. There are "voices" occasionally as well as "visions," and ear-minded people dream less, no doubt, in visual terms. But the dreamer is the "seer," as our very language shows.

Now, there is, in the nature of mental life, no reason why our images should be drawn so largely from the sense of sight. It is an accidental circumstance, due to the fact that we use the eye more than any of the other organs. The difference is both quantitative and qualitative. Our ears, to be sure, are never closed, but if we note the character of our auditory perceptions, we see that little attention or intelligence is needed in this direction. The significance of what we hear bears no comparison with the significance of what we see. In every-day life the principal office of the ear is the apprehension of spoken language. The limited and ever-repeated vocabularies of our verbal symbols call for little discriminative use. Thus far the ear is a drudge, carrying lifeless symbols to be interpreted. Even the spoken word is by many persons mentally turned immediately into the visual image, either of the thing represented or the printed or written word. On the other hand, some people, in reading, mentally represent the spoken word, but it is the motor representation of the *spoken* word, not a sensory image of its sound. The intelligent hearing of music forms a notable exception to the usual mechanical action of the ear, yet in the life of the average man the time given to music is comparatively insignificant.

The eye is not only more active, but its action is more intelligent. It brings us into closer relations with the outer world. It gives us not a time series of single elements, but a constantly changing space series of numerous elements. It is the constant and normal interpreter of our outer life. By its means we select our food, recognize our friends, detect our enemies, guide our steps, and co-ordinate the movements of our arms and hands in eating, drinking, writing, reading, sewing, weaving, cooking, washing, plowing, planting, building, painting, drawing, driving, rowing, fencing, and in innumerable other manual dexterities. In all these movements our actions have become automatic—that is, they are directed reflexly by the muscular sense, but still always need some assistance from the higher senses, and the sense used in almost all cases is the sense of sight. For instance, with closed eyes we can write, but imperfectly. A practiced musician may play with closed eyes, but commonly, even in this art pertaining to the ear, the eye is busy, glancing at the keys and following intently the printed score. So far has our eye-mindedness gone that we use the word "see" not only for purely intellectual perception, but even for perception by the other senses. We say that we *see* the fallacy of an argument, or we *see* that the paper is smooth, or the orange sweet, or even that the piano is out of tune, when we mean that we understand, or feel, or taste, or hear.

Now, in the use and relative importance of the two higher senses there has been a marked change even in historic times. It is possible, indeed, to trace the evolution of the eye during the last two thousand years, and to discover some of the causes producing the change. The ancient Greeks, for example, were ear-minded. By this is not meant that the sense of hearing was at that time absolutely more prominent than the sense of sight, but relatively so. Notice, then, how the Greeks used the ear, with its complementary organ, the tongue, while we use the eye and the hand. They were a conversing people; we are a writing and reading people. With them poetry was sung or recited; with us it is read. They conducted politics in the Agora; we in the newspaper. Success in political affairs depended with them largely upon oratory; with us but slightly. The instrument of philosophy and discussion was with them conversation (dialectic); with us it is the monthly or quarterly review. With them music was the most prominent branch in popular education; with us it is least so. Although the principle of Greek education was harmony of all the physical and mental powers, we have only to glance at the educational system at Athens to see the comparative unimportance of eye education. In the training of Athenian youth, next to gymnastics, music received the most attention, and grammar—the remaining one of the three elementary subjects—included learning as well as reading the poets. Music included not only singing and playing upon the cithara and lyre, but also the cultivation of poetry. Music and poetry, again, were not cultivated as fine arts by the wealthy and leisurely classes merely, but were a part of the very life of the people. They were composed, too, upon the tongue, not upon paper, and they were apprehended and learned by the ear, not from a score or book. Even the laws were taught in song at Athens. Law and tradition, music and poetry, even arts and sciences, were transmitted orally from one generation to the next, apprehended by the ear and stored in the memory. In earlier times, when writing was not in general use, codes of laws, Homeric poems, and Vedic hymns were transmitted orally and accurately from generation to generation. Instruction in those days did not come through the cold medium of a book, but directly through the living words of parent and teacher This constant use of memory and reliance upon it gave it strength, and a man's learning, if limited, was at least in his head at command and not in his library. Compare modern fiction with that of other times. Then stories were told, not written; and listened to, not read. To say nothing of the training it gave the memory, was there not something more humanistic in the social company of story-tellers and eager listeners than in the modern writing and reading of novels? Now, the novelist alone in his study tediously composing and the reader alone in his room mentally devouring the printed page present phases of life that are unsocial, if not unhealthful and unnatural.

In the "good old times" men depended for their knowledge upon what they had either learned for themselves or heard and remembered. Now we depend, to a great extent, upon our libraries and books of reference. We quote the writings now, not the sayings, of great men, and do not come directly under their personal influence. In this respect there has been a great change even within a century, as books have multiplied and students are gathered less in the literary centers. As an example of our dependence on written authorities, may be mentioned the popular apotheosis of Webster's and Worcester's dictionaries. The old worship of the Bible seems to have been weakly transferred to the dictionary. In buying one of these books a person congratulates himself if, by paying a trifle more, he gets a supplement with a universal pronouncing biographical dictionary or gazetteer, forgetting that it is better to become acquainted with the works of one great man than to know when five hundred great men were born and how their names were accented; and that it is better to go and visit one range of mountains or large city than to learn by staring at a map where all the cities and mountains are.

Our prevailing eye-mindedness is further shown by the readiness with which the mind is impressed through the eye, and the ease with which visual images are retained. A teacher, wishing to impress some essential point, illustrates or even writes the same upon the blackboard. A child who has been *told* a hundred times, without result, to correct some fault, finally learns the new way at once when presented to him by sight or touch. In physics, mechanics, and mathematics the so-called "graphic method" is used more and more. When other forms of illustration fail, we fall back upon the visible curve. The sociologist lays down his abscissas and ordinates and illustrates to the eye by curves the relation of the increase of crime to the scarcity of corn. Many teachers believe that the pedagogical discovery of our age is that it is easier to impress the mind through the eye than through the ear. This is undoubtedly true, and such teaching is successful, if by success is meant the mere imparting of instruction, so that it is understood and retained. In every subject the blackboard is freely used, and in many has become indispensable. The old-fashioned mental arithmetic has given place to the so-called "practical" arithmetic, a name which seems to be a misnomer, since the student of it is, for the rest of his life, committed to the use of pencil and paper for any mathematical computation higher than the multiplication table. Grammar even is taught by diagrams, and logic by circles. Blackboards, maps, and charts cover the walls of our school-rooms; globes, figures, models, chemical and physical apparatus, cover the tables. This constant appeal to the eye, prevails not only in our intermediate schools but also in our Kindergartens and in our colleges. In the former, instruction is by *object-lessons*. Excepting some exercise in singing, all the instruction is in form and color and in manual training. The student thus trained with respect to his eye and hand from the primary to the high school, selects, when he enters college, subjects for which he is best prepared. These are the material sciences and arts with their experimental laboratories, and their visible and tangible material and apparatus. In our colleges and universities, therefore, we notice the yearly increasing prominence given to the material sciences and to branches of technology, and the crowding out of the time-honored humanistic studies. These so-called "liberal arts," studied for subjective culture rather than for objective utilities, have, during the whole history of education, figured as the central and principal group of studies in higher education, and still do so to a large extent in our older colleges and in European universities. Among the subjects thus contracted by the pressure of the material arts and sciences may be mentioned mathematics, studied as an end, not as a means; logic, the science of thought; ethics, the science of conduct; classical literature; music, the most cultivating of the fine arts; and, to some extent, history and politics. Language is much studied, but more for utility than for culture. Hence Greek and Latin give way to the modern languages. But even language does not check our eye-mindedness. Here, if anywhere, one would suppose that the ear and tongue would be trained. Curiously enough, it is again the eye and hand. Greek and Latin are usually studied by sight. We learn to read them and possibly to write them, but not to understand or speak them. This is to some extent true also of modern languages. The French and German learned in our schools and colleges are the written rather than the spoken languages. Strange though it is, since language is the rightful inheritance of the ear and tongue, and is the very groundwork of our social life, that our young people should be found studying it silently in their several places, thumbing their pens and their printed dictionaries, yet the explanation is not far to seek. We are a reading rather than a speaking people, and the written language is of more use to us than the spoken. We care more to be able to consult French and German books than to converse with French and German people. To be sure, there is at present a wide-spread movement among language-teachers to correct this evil; but, as a fact, language is studied in the same old way, and few students seem to understand that a language is not known unless it is known to the ear and tongue.

If now we seek the causes of our prevailing and increasing eye-mindedness, we shall find them chiefly in the invention and rapid extension of printing, engraving, and photography. These are the arts that have drawn so heavily upon our visual resources and made it so easy to dispense with the ear and the memory. The yearly increasing time given to reading and writing, compared with the time given to listening and speaking, is apparent to everybody. The present generation is a book-and-newspaper-reading generation. We get our politics from the daily paper, our art from the magazine, our science from the text-book, our amusement from the novel, our gossip from the biography, our facts from the cyclopædia. We speak of the man of education as the "well-read" man. He reads, of course, extensively in some special subject connected with his work or profession. As a foundation for this, however, he has read some standard works in mathematics, or philosophy, or physical science, or history, or philology. Of the classical writers he has, of course, read a few, such for instance as Shakespeare, Milton, Goethe, Schiller, Byron, Wordsworth, Burns, Tennyson, Browning, Longfellow, Bryant, Poe, Dante, Virgil, Horace, Homer, Hume, Gibbon, Macaulay, Motley, Prescott, Bancroft, Livy, Herodotus, Cicero, Carlyle, Webster, Irving, Emerson, Pascal, Voltaire, Ruskin, Plato, Kant, Mill, Darwin, Spencer, Scott, Dickens, Thackeray, Cervantes, Hugo, George Eliot, Bulwer, Kingsley, Hawthorne, Brontë, Black, Collins, Dumas. Besides these, or many like them, he has read a great number of contemporary writings, including novels, travels, biographies, essays, philosophy, science, and art. New books, reviews, and articles, relating to his profession or specialty he must, of course, be constantly reading. Besides these he must at least glance over some of the leading articles in the best of the hundreds of weekly, monthly, and quarterly periodicals, magazines, and reviews. Then there is his private correspondence with daily letters to read and write. With all this mass of reading, however, he might not become quite a reading machine, and might find a little time for the use and cultivation of other bodily organs than the eye, were it not for the daily paper. The tireless steam press ruthlessly grinding out some thousand large pages per hour has become a kind of tyrant rather than a servant of man. By what curious perversion of modern conscience have we learned to believe it our daily duty to read that A. B. robbed a bank in New York and that C. D. wrote a book in Boston, that E. F. married a wife in Maine and that G. H. killed one in Missouri, that the weather is colder in California and warmer in France? But if we have learned to skip the crimes and casualties, we consider it our bounden duty daily to scan at least the field of politics. What one reads others must write and print. Day and night, therefore, editors, reporters, correspondents, and printers are busy with eye and hand.

As a result partly of our eye-mindedness, partly of our conditions of life, a number of arts both æsthetic and useful have sprung into being or into new life, which promise still further to increase the use of the eye. Among these we may mention the art of decoration exhibited in architecture; in the internal embellishment of dwellings, churches, and public buildings; in dress, unless we rank this as a separate fine art; in stage decoration, in floriculture, and in many other ways. There is next the art of illustration, which has enormously increased the circulation of certain classes of books, magazines, weekly and even daily papers. Then there is photography, an art which has lately received a wonderful expansion, made popular on the one hand by cheap and rapid processes, on the other hand applied to the highest scientific purposes. No less have drawing and designing extended their fields in every direction. Type-writing as a brand-new art has sprung into existence; and, finally, the art of advertising has gained a distinctive place, scores of pages in a single magazine being covered with these silent but fascinating appeals to the eye. In all these and in many other ways the eye and the hand are called into ceaseless and intelligent use, while the ear and the tongue are idle.

There are, or at least there were, three good old arts involving the use of the ear and the tongue—namely, music, oratory, and conversation. If, as the Greeks believed, the highest good be the harmonious exercise of all our powers, there are no other arts whose loss or deterioration at the present time society could so ill afford. Of these, music is the first in worth and fortunately has suffered least thus far from the decline of the organs upon which it depends. But music, although carried to a high degree of perfection by specialists, has no longer its former place in the home and in the life of the people. Musical instruments are many, and a kind of solitary, eye-and-hand music is common enough. Contrast also the influence of the opera and theatre. The people prefer to go to the latter to *see* rather than to the former to *hear*. Notice, too, the tendency to make both the theatre and the opera spectacular to meet the popular demand for something to please the eye, so that we go even to the opera to see rather than to hear. When Richard Wagner substituted the "musical drama" for the opera, it was not merely an innovation in music nor a union of all the arts of the stage, but rather a surrender of the language of sound to the language of form.

In its three most distinctive fields, oratory is suffering a considerable deterioration. These are the pulpit, the bar, and the legislative hall. The preacher no longer tells his hearers what he knows, but reads to them what he himself has read from the commentary or the review. The widely bemoaned decadence of the pulpit is not alone due to the decay of theologies, but also to the loss of that on which its vitality depends—power to speak and to listen. Listening, too, is a lost art. At church we are often engaged in an intent review of our own mental images; in conversation we are not so busied apprehending what is said as considering what we shall say. When we wish, therefore, to attend to and remember an address or lecture, we find both difficult. In the practice of law oral pleading has been superseded to a considerable extent by the type-written brief. In our legislative assemblies the machinery of the caucus and committee-room has taken the place of the direct oral appeal.

The last of our voice arts is conversation. A recent writer in The New Review, in an article on Talk and Talkers of To-day, calls in question the "commonplace of social criticism" that conversation is a lost art, and instances Mr. Charles Villiers, Mr. Gladstone, Lord Granville, Mr. Morley, and Lord Salisbury as talkers who may be compared with Sydney Smith, Macaulay, Lord Derby, and Bishop Wilberforce. But one might well ask whether these are talkers of to-day or yesterday. Good talkers no doubt there are even in the younger generation, but in comparison with the number of scholars of the day the number of good talkers is pitifully small. What men know they have acquired for the most part through the eye, and such knowledge is not in form to be brought out readily through the mouth. This is a generation of readers, writers, thinkers, experimenters, inventors, but not of talkers. Under our present conditions of life we may expect conversational power to decline still more than it has done.

In conclusion, it may be asked what the effect of our eye-mindedness is and will be upon the memory. Psychologists no longer speak so much of the memory as the memories. With the greater use of the eye, the eye-memory will gain; with the lesser use of the ear the ear-memory will lose. Practically, however, our present mental habits are destructive of our retentive powers generally. To the vast number of visual impressions made upon the mind daily, it is impossible to apply the two principal conditions of good memory—attention and repetition. Newspaper reading may be taken as a good illustration of our memory-destroying habits. In a half-hour devoted to "glancing over" a bulky newspaper, many thousand visual impressions may be received. To the sensations themselves we pay no attention, and usually but little to the words or to the thoughts represented. The matter we read is not worth careful attention nor any repetition. We retain little or none of it and do not care to. An item that we may wish to retain for future use is perhaps cut out and pasted in a scrap-book, and, lest we fail even to remember where it is, our scrap-book has an index. The eye-educated man is found to be well posted in a subject, provided he has a day's notice in which to "cram" from his note-books and library. Nothing suffers so much by disuse as memory. The memory age is past. The merchant has found a better way of keeping his accounts than in his head. Everywhere a man's necessary knowledge far surpasses his retentive capacity. Some will say that this is merely an incidental change in the direction of our mental activity due to our changed conditions of life, and indeed an economical change. Any real deterioration of memory, however, would be a loss of mental symmetry for which there could be no compensation.

In our present enthusiastic devotion to the eye it is not alone the symmetry of the mind that is threatened nor the voice arts alone that will suffer. It may be that we are neglecting that which is in itself one of the richest sources of good. It has not yet been shown that the world of form is more worthy of our cultivation than the world of sound. "There is something as yet unanalyzed about sound," says Mr. Haweis, "which doubles and intensifies at all points the sense of living: when we hear we are somehow more alive than when we see. Apart from sound, the outward world has a dream-like and unreal look—we only half believe in it; we miss at each moment what it contains. It presents, indeed, innumerable pictures of still life; but these refuse to yield up half their secrets."

EXERCISE FOR ELDERLY PEOPLE.

By FERNAND LAGRANGE.*

THE tissues and organs do not all mature at once in man. It results that when we reach mature age our capacity for some exercises has notably diminished, while for others it has preserved its complete integrity. At forty-five years the bones and muscles have lost none of their solidity and vigor. The aptitude for exercises of force and bottom continues. But we can not conclude from this that the man is as apt in all forms of exercise as he was at twenty-five. While the motor apparatus proper is not sensibly modified in the maturity of life, particularly if one has kept it up by regular practice, this is not the case with some other apparatus that begin to decline earlier—notably with that for the circulation of the blood. The heart and the arteries, in spite of the most rational exercises, lose with age a part of their serviceableness, because they lose some of their normal structure.

After thirty-five years of age we recognize, even in conditions of perfect health, a tendency to sclerosis, a defect in nutrition that lessens the suppleness of the vessels and causes them to lose a part of their elastic force. This change, which goes on with increasing age, has received the picturesque designation of the "rust of life." Rust in a machine is the result of a lack of work, while deterioration of the blood-vessels is connected with the working itself of the human machine; it is the result of the wearing out of its most essential wheel-work, and it is to be observed most prominently in men who have carried exercise or work to the point of abuse. All directions for exercise in mature age, all precautions to be taken in its application, are controlled by this great physiological fact of the lessened capacity of the vessels to support violent shocks. This imperfection of the arterial system is the cause of a considerable tendency to shortness of breath; and it is by this shortness of breath that the man's diminished capacity for resistance is shown.

The differences in the structure of the arteries, even though they may not be carried so far as to denote disease, make the man

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of fifty years much more vulnerable than the young man; and vulnerable in precisely the organ most essential to life. It is, in fact, the heart that suffers in case of forced exertion, the consequences of a deficient elasticity of the arteries. Every beating of the heart represents the piston-stroke of a force-pump, and the blood-vessels are the pipes through which the liquid flows to carry life to the furthest molecules of our body. But these vessels are not inert conductors; they are endowed, in a healthy condition, with an elasticity which permits them to react at each pulse of the heart, swelling under the pressure of the sanguineous wave, and then contracting and returning to the liquid the impulse which they have received from it. The liquid, striking upon the wall of a fully elastic artery, does not suffer at once the arrest which it would suffer on meeting a rigid wall. A billiard-ball, driven against a very elastic cushion, rebounds with nearly as much force as it had when it started. An artery which has lost its elasticity is, as to the column of blood that comes against it, as an ivory ball to a cushion that does not spring. And as the billiard-player must strike more vigorously upon the ball to make it perform its run when the cushions do not spring, so the heart, when the artery has lost its elasticity, must exaggerate its effort at the systole to enable every molecule of blood to traverse the circle of the vessels and return to its point of departure. In short, the less elastic the arteries, the greater the effort the heart has to make to secure equal work. Each heart-beat, then, of a man whose arteries have become old, is the occasion for an excess of labor by the cardiac muscle. The increase in expenditure of force passes unnoticed if the beatings retain their normal slowness, but becomes very sensible when they are quickened. There are some exercises which cause the number of heart-beats to double in a few moments. The resultant fatigue of the organ, which has already been brought to the point of overwork by the continual excess of work it has had to do, is easy to conceive.

The most natural consequence of fatigue of the heart is a momentary diminution of its energy; and when the organ is weakened, the impulse it gives to the blood is no longer sufficient to cause it to traverse as rapidly as it ought the vessels through which it circulates with most difficulty, either on account of their narrowness, or of the mass which is precipitated into them at once. Hence what are called passive congestions of the internal organs, and particularly of the lungs. Congestion of the lungs is a frequent consequence in elderly men of exercises which accelerate to excess the rhythm of the pulse, and is shown by shortness of breath. This, which is more prompt in men habituated to physical exercises, is one of the first symptoms of arterial deterioration. It is a warning which it would be a grave imprudence not to heed.

The elderly man should therefore give up all exercises of speed like running, and all those in which energetic efforts are added to speed, like rowing in matches. We see men of exceptional powers of resistance continuing to practice exercises of speed till they are forty-five years old; but it is well to know how indulgence in championship feats late in life usually ends. Many affections of the heart are consequences of exercises or labors that exaggerate the effort of that organ in men who have reached maturity. The central organ of the circulation can not be subjected without danger to excessive work, when its play is not seconded by the elastic force of an unimpaired arterial system; when it is partly deprived of the re-enforcement which is lent it by these contractile channels, the office of which in the circulation of the blood has been happily described by giving them as a whole the name of the "peripheric heart."

All men who employ animals in work know how their speed falls off with increasing age. Race-horses are withdrawn from the track shortly after they have arrived at the full possession of their force; they are still good for competitions in bottom, and are capable for many years yet of doing excellent trotting service, but they can not run in trials of speed. Man's capacity to run likewise decreases after he has passed thirty years; and the professional couriers who are still seen in Tunis, running over large distances in an incredibly short time, are obliged to retire while still young. Those who continue to run after they are forty years old, all finally succumb, with grave heart affections.

There are some persons who preserve to a relatively advanced age the faculty of enduring violent exercises, and of contesting with young persons in quickness of muscular work. Not long ago two men, one forty-five and the other forty-eight years old, contested in the regattas on the Seine and Marne. Their craft was called the old men's. Few oarsmen continue to row in races after they are thirty-five years old. But those whom we are speaking of, though long past the usual age for retiring, have often gained the prizes which competitors twenty years old disputed for with them. These exceptions, however, do not depreciate the force of the principles we have just explained. They prove that one may be young in spite of his years, and that the chronological age does not always agree with the physiological age. While some persons are in full organic decadence at thirty-five years, some others may not yet, at fifty years, have undergone the modifications of nutrition which are the beginning of old age. The capacity of a man for violent exercises is determined by the more or less complete integrity of the arterial tissues. Men who preserve a degree of immunity for exhausting exercises longer than the average are those whose circulation has remained regular, and whose arteries have not yet begun to undergo sclerotic degeneration. They are really younger than their age. Every man, according to the happy expression of Cazalis, is "of the age of his arteries," and not of that which he deduces from his birth. Taking a mean, we may say that after forty years a man ought to abstain from exercises that induce shortness of breath. Instead of exercises of speed, he should adopt those requiring bottom, for which he will preserve a remarkable capacity. Race-horses which have become incapable of enduring labor that involves speed may for many years afterward perform excellent service at more moderate paces; they may even easily endure the paces of the hunt, when they have to carry their rider for the whole day, but in which the fundamental gait is not the gallop but the trot. So man preserves to the extreme limits of mature age the faculty of enduring a considerable labor for many hours, provided it is carried on with moderation. Many of the best mountain guides are approaching their sixties, and can easily tire young tourists. But everybody has remarked that the most experienced guides—that is, the oldest ones—go up very slowly, and that under that condition they can walk for an indefinite time. They do this by avoiding, through the moderation of their pace, the quickening of their pulse and the imposition of an excess of work on their heart.

In 1870, when the dangers of the invasion called all French citizens to take part, each one according to his ability, in the defense of the country, national guards of the reserve were organized everywhere, in which all those who for any reason had not been incorporated in the active service were enrolled. In the exercises of these improvised battalions, men of very unequal ages could be seen elbowing one another in the ranks. Many of them, who had passed their fortieth year, but felt themselves still "game," came to take part in the manœuvres, and were never behind in the long drill-marches. Generally, indeed, the elderly men displayed a greater power of resistance than the younger ones. But their superiority vanished as soon as the manœuvres took the form of quick movements. The "gymnastic step" was the terror of these well-intending veterans; after one or two minutes of the run they could be seen leaving the ranks out of breath, while the younger ones, whom they had left behind on the long marches, kept on for a considerable time without feeling any obstruction to their breathing. Serious accidents were sometimes produced in these movements, when they were commanded by too zealous officers who forced the men to keep up their speed notwithstanding the difficulty in their breathing; and national guards were sometimes seen, from having run too long in the face of threatened suffocation, to fall in their places, struck with pulmonary congestion.

Exercises of force would also be as badly chosen for elderly men as exercises in speed, and for the same reason—that they fatigue the blood-vessels and the heart. Every muscular act that requires a considerable display of force inevitably provokes the physiological act called effort. A porter in lifting a heavy burden is obliged to make an effort, as does also the gymnast who executes an athletic movement with his apparatus. These are common facts of observation, and impressions which everybody has felt. If we put all possible energy into any movement, respiration stops at once, the muscles of the abdomen stretch, and the whole figure is stiffened, while the veins swell and mark salient sinuosities on the neck and forehead. I have explained the mechanism of effort in my book on the Physiology of Effort. It is enough to recollect here that it increases in excessive proportions the tension of the blood-vessels. Effort is translated, in fact, by a considerable pressure of the ribs on the lungs, and through this upon the heart and large vessels; under the influence of this pressure there is a reflow of the mass of the blood toward the smaller vessels and distention of their walls. When these vessels are tending to lose their elasticity, in consequence of the modification of structure observed in mature age, the violence to which the effort subjects them results in the aggravation of their inert state. In the same way the "fatigue" of a steel spring which has had too much to bear is increased again after every violent pressure to which it is subjected. Nothing wears out a man who has reached maturity like great physical efforts, because nothing can more than effort aggravate the effects of that defect of nutrition which is called sclerosis.

In some cases arterial sclerosis is nothing but the gradual and slow consequence of the advance of age, but assumes a rapid pace that makes it a fearful malady. In such cases we can see young persons presenting the same physiological reactions against fatigue as the elderly man. One of the first symptoms of that acute aging of the arteries which is called arterial sclerosis is the dyspnœa of effort.* All elderly men are, in different degrees, tainted with arterial degeneracy, and all ought to avoid excessive muscular effort if they would not wear out their arteries before the time—that is, would not grow old prematurely; for every man is "of the age of his arteries."

While the elderly man has less capacity for some forms of exercise than the younger adult, he has no less need than the

* See Huchard, Maladies du Cœur et des Vaisseaux, 1889.

other of the general and local effects of exercise. It is in the earliest period of mature age that the most characteristic manifestations of defects of nutrition—obesity, gout, and diabetes, in which lack of exercise plays an important part—are produced; and the treatment of them demands imperiously a stirring up of the vital combustion. Placed between a conviction that exercise is necessary, and a fear of the dangers of exercise, the mature man ought, therefore, to proceed with the strictest method in the application of this powerful modifier of nutrition. It is impossible, however, to trace methodically a single rule for all men of the same age, for all do not offer the same degree of preservation. We might, perhaps, find a general formula for the age at which the muscles and bones have retained all their power of resistance, and at which the heart and vessels begin to lose some of their capacity to perform their functions. The mature man can safely brave all exercises that bring on muscular fatigue, but he must approach with great care those which provoke shortness of breath.

The formula is thus subjective in its application, in the sense that it looks rather to the feeling of the person than to the exercise itself; and from this point of view it is exactly applicable to all. One person is taken with shortness of breath at the beginning of a fencing bout; another one of the same age can fence without losing breath, while he tires his legs and arms. Most frequently the question of measure in the practice of exercise is more important than the choice of the kind. Some exercises are dangerous only on account of the temptation they offer to impetuous temperaments to pass beyond reasonable bounds. Thus fencing, which prematurely wears out too enthusiastic swordsmen, may remain a very hygienic exercise for the man of fifty years, provided he is enough master of himself to moderate his motions. There are exercises, however, which of themselves imply the necessity of a violent effort or a rapid succession of movements; among these are some of the exercises with gymnastic apparatus, wrestling, and running. These should be absolutely prohibited to the elderly man. This rule can not be invalidated by the rare examples of men who have been addicted to such exercises till an advanced age. Such men have continued, in respect to their structure, younger than their age; they have kept their elastic arteries as other persons keep their black hair. They are physiological exceptions, and general formulas do not regard exceptions.

The need which the elderly man feels of a stimulation of his organic combustion may be satisfied in other ways than by exercises of strength and agility. It is, in fact, the sum of work that regulates the quantity of heat expended by the human body, and that is proportioned to the quantity of tissues burned, to the amount of oxygen consumed in the acts of vital chemistry that constitute nutrition. It is possible to reach a considerable sum of daily work without at any moment making intense exertion or rapid movements. The muscular acts of exercises chosen have for that only to be continued long, without being very violent or very rapid. In other words, it is enough that the exercise represents "bottom" work.

Walking is the type of "bottom" exercise, and is the most hygienic of all kinds for the elderly man, provided it is prolonged enough to represent a sufficient amount of work. Nothing is so good for the man of fifty years as a gunning tramp, or long pedestrian tours like those the Alpinists make. But it is necessary to regard the social exigencies, which refuse to give everybody the desired number of hours, and compel another choice. There are many other "bottom" exercises that exact a larger expenditure of force than walking, without going beyond the degree of effort and rapidity that the arteries of the elderly man can safely bear. Many of what are called open-air games, like tennis, lawn-tennis, and even rowing, when practiced not for racing but as a recreation—that is, with a liveliness graduated to the respiratory capacity of the rower—provoke, for example, in one or two hours, an elimination of the products of disassimilation and an acquisition of oxygen equivalent to what one can get from eight or ten hours of walking. They permit the busy man to gain time, compensating for the shorter duration of the exercise by its intensity; but that in such a way that he can get the general consecutive effects of exercise while avoiding its general immediate effects, super-activity of the circulation of the blood and of respiration.

We ought to look also to exercise for local effects; in order, in the first place, to keep the joints supple and counterbalance the tendency to incrustation of the cartilages, which is one of the consequences of age; and, in the second place, to keep the muscles as a whole in sufficient strength and volume. The muscle, as we have read, is "the furnace of vital combustion," and in developing the muscular tissue we favor the activity of combustion and the destruction of the refuse of nutrition. For the satisfaction of these requisitions, such exercises are adopted as might be called analytical, inasmuch as they bring the whole muscular system into play, not by the work of the whole together, but by a series of successive movements that call the various muscular groups into action severally one after the other. It is important, in order to preserve the easy working and suppleness of all the articulations of the body, to subject them to movements extending to the extreme limit of possible displacement. We might also, by localizing the work successively in limited muscular groups, effect very intense muscular efforts without any fear as to their reaction upon the organism or upon the circulation of the blood. The floor exercises of the Swedish gymnastics exactly fulfill the conditions needed to obtain suppleness of the joints; similar exercises, according to the French method, would be well fitted for the object of preserving or increasing the local muscular development.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

LIFE ON AN OSTRICH FARM.

THERE is an air of delightful unrestraint about Mrs. Martin's story of her Home Life on an Ostrich Farm.* She addresses her reader from her book as she would gossip to a confidential friend about her adventures, and describes them all with photographic vividness. We receive, as if to the very life, her first impressions of Cape Town, the Veldt, the Karroo district in which her home was situated; the farm itself, with its peculiar vegetation, birds, beasts, and reptiles; her own and her husband's trouble at not being able to realize the house of Algerian architecture which they had dreamed of; the long drought and the flood, indoors as well as out, by which it was so rudely broken; and the incidents, the humors and pleasures, mishaps and sorrows, of ostrich-raising.

Mr. and Mrs. Martin having removed to South Africa to go into the ostrich-raising business, settled on a tract of twelve thousand acres in a long valley so hedged in by steep mountains that little inclosure was necessary. It was in the part of the Karroo called the Zwart Ruggens, or black, rugged country, from the appearance it presents in the long droughts, when the vegetation turns to a forbidding black and is seemingly all dried up. But the sticks, when broken, are found all green and succulent inside, and full of a nourishing saline juice; and thus, even in long droughts, which sometimes last more than a year, this country is able to support stock in a most marvelous manner.

The little karroo plant, from which the district takes its name, is one of the best kinds of bush for ostriches as well as for sheep and goats. It grows in small compact, round tufts not more than seven or eight inches high, and, though very valuable to farmers, is unpretending in appearance, having tiny, narrow leaves, and a little, round, bright-yellow flower, "exactly resembling the center of an English daisy after its oracle has been consulted and its

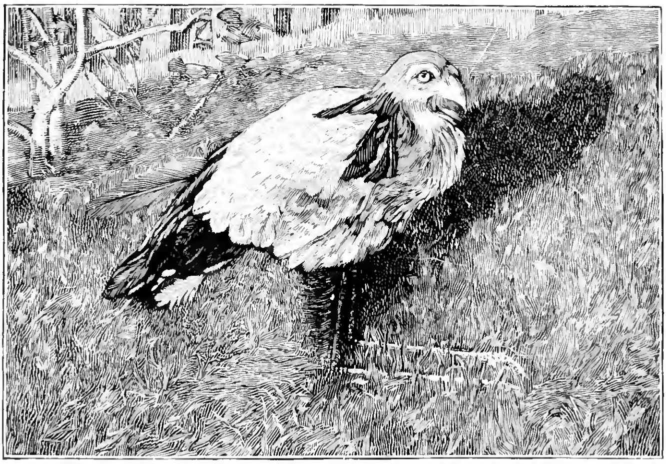
* Home Life on an Ostrich Farm. By Annie Martin. New York: D. Appleton & Co. Pp. 283.

last petal pulled by some inquiring Marguerite." The *fei-bosch*, another common and useful plant, has a pinkish-lilac flower, very like that of the portulaca, and little flat, succulent leaves, looking like miniature prickly-pear leaves without the prickles. A third ostrich-bush plant is the *brack-bosch*, a taller and more graceful

SOME OF THE BEST KINDS OF OSTRICH-BUSH.—1. BRACK-BOSCH. 2. GHANNA. 3. FEI-BOSCH.

plant than the others, with blue-green leaves, and blossoms consisting of a spike of little greenish tufts. There are an endless variety of other plants, among which there is hardly one that is not good, nourishing food for the birds. "All are alike succulent and full of salt, giving out a crisp, crackling sound as you walk over them; all have the same strange way of growing, each plant an isolated patch by itself, just as the tufts of wool grow on the Hottentots' heads; and the flowers of nearly all are of the portulaca type, some large, some small, some growing singly, others in clusters; they are of different colors—white, yellow, orange, red, pink, lilac," etc. They are very delicate and fragile, and fade as soon as they are gathered. The prickly pear is an introduced plant, but has become a nuisance, and brings great trouble upon the ostriches, which acquire a morbid taste for them, and ultimately succumb to the effect of the prickles that lodge in their throats and can not be got rid of.

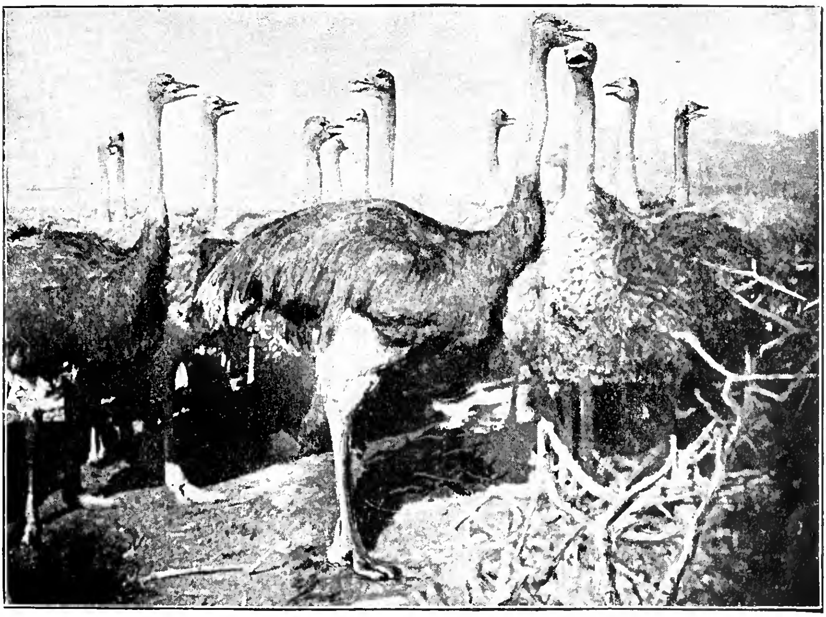
The feathered and four-footed creatures of the country were all delightful, having the quaintest and most amusing ways, and were easily tamed; so that our settlers soon had a considerable menagerie around them. Their first acquisition was a secretary bird — Jacob — which, on first coming to live with them, reminded them "of a little old-fashioned man in a gray coat and tight black knee-breeches, with pale flesh-colored stockings clothing the thinnest and most angular of legs," the joints of which worked rather stiffly. "Not by any means a nice old man did Jacob resemble, but an old reprobate, with evil-looking eye, yellow-parchment complexion, bald head, hooked nose,



Jacob.

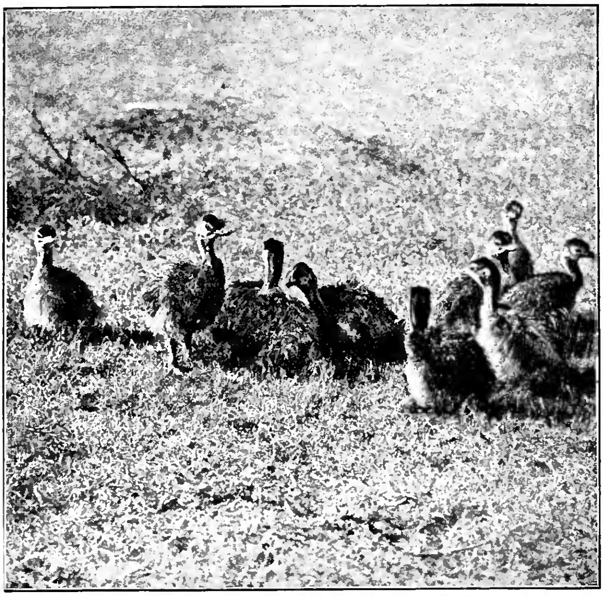
and fiendish grin; with his shoulders shrugged up, his hands tucked away under his coat-tails, and several pens stuck behind his ear." He was nevertheless very friendly and affectionate, and soon grew too tame and noisy. He would intrude into the house and persist in staying there, till, when all other efforts to drive him away had failed, a dried puff-adder's skin, of which he stood in mortal terror, was thrown at him, when he would run off and be gone for the day. The Cape Government protects these birds for their usefulness in destroying snakes. This one had a voracious appetite, and an enormous capacity for swallowing lizards, rats, toads, frogs, locusts, young chickens, and kittens.

The most serious drawback to the Cape Colony as a place for settlement lies in the long droughts, which "are certainly very trying; indeed, they could not possibly be endured by any country less wonderfully fertile than South Africa, where it is calculated that three good days' rain in the year, could we but have this regularly, would be sufficient to meet all the needs of the land. But often, for more than a year, there will be no rain worth mentioning; the dams, or large artificial reservoirs, of which each farm usually possesses several, gradually become dry; and the Veldt daily loses more of its verdure, till at last all is one dull, ugly brown, and the whole plain lies parched and burned up under a sky from which every atom of moisture seems to have departed. . . . The stock, with the pathetic tenderness of thirst,



Ostriches in a Hot Wind.

comes from all parts of the farm to congregate close round the house; the inquiring ostriches tapping with their bills on the windows as they look in at you, and the cattle lowing in piteous appeals for water; and you realize very vividly the force of such scriptural expressions as 'the heaven was shut up,' or 'a dry and thirsty land where no water is.' Then the hot winds sweep across the country, making everybody tired, languid, headachy, and cross. . . . Even our pets were sulky on a hot-wind day; and as for the ostriches, they were deplorable objects indeed, as they stood gasping for breath, with pendent wings, open bills, and inflated throats, the pictures of imbecile dejection." For water-supply during these terrible seasons the farmers build dams where the waters of the thunderstorms are collected and stored. But even the most capacious lakes thus formed must dry up in a long drought;" and that land-owner is wise who does not depend solely on this form of water-supply, but who takes the precaution of sinking one or more good wells. This is expensive work, . . . but

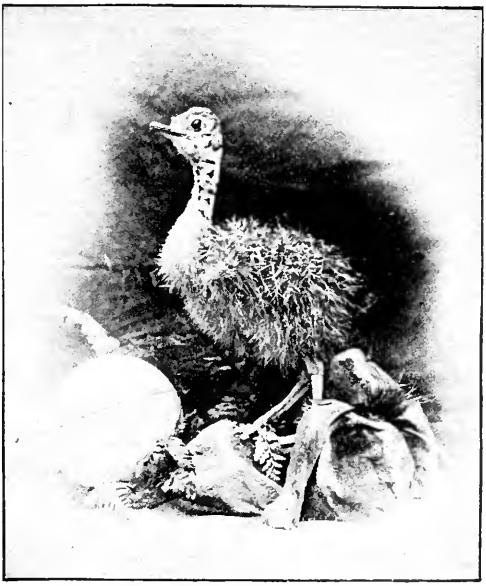


Ostrich-chicks.

the advantage is seen during the protracted droughts. Then, on farms which only possess dams, the ostriches and other stock are seen lying dead in all directions, a most melancholy sight. Where there is a well, however, the animals can always be kept alive. The water may go down rather low, and the supply doled out to the thirsty creatures may not be very plentiful; but with careful management no stock need be lost during the longest of droughts."

In the early days of ostrich farming splendid fortunes were made. Feathers were worth $500 a pound, and $2,000 or $2,500 was no uncommon price for a good pair of breeding birds, while little chicks were worth $50 each. Indeed, the unhatched eggs have sometimes been valued at the same amount. But with the larger supply, $60 may be regarded as a fair price for the best pair of ostriches, and 30 shillings, as against £25 in the old times, for the feathers of the handsomest bird at one plucking.

There are not many young animals, says Mrs. Martin, "prettier than a young ostrich chick during the first few weeks of life. It has such a sweet, innocent baby-face, such large eyes, and such a plump, round little body. All its movements are comical, and there is an air of conceit and independence about the tiny creature which is most amusing. Instead of feathers, it has a little rough coat which seems all made up of narrow strips of material of as many different shades of brown and gray as there are in a tailor's pattern-book, mixed with shreds of black; while the head and neck are apparently covered with the softest plush, striped and colored just like a tiger's skin on a small scale." As they grow they lose all their prettiness and roundness, their bodies become angular and ill-proportioned, and a crop of coarse wing-feathers sprouts from the stripes.



Ostrich-chick.

The "chicken feathers" are plucked for the first time when the bird is nine months old. They are stiff and narrow, with pointed tips, and do not look as if they could be used for anything but making feather brooms. The quality is improved in the second year; but it is not till their wearer is plucked for the third time that the feathers have attained their full width and softness. During the first two years, when their plumage is all of a dingy drab mixed with black, the sexes can not be distinguished. Then they begin to differentiate; and at five years, when the birds have attained maturity, the plumage of the male is of a beautiful glossy black and that of the female of a soft gray, while both have white wings and tails. In each wing there are twenty-four long white feathers, which, when the wing is spread out, hang gracefully round the bird like a deep fringe The thighs are bare and the flat head is bald, except for a few stiff bristles and scanty tufts of down. During the breeding season the bill of the male bird and the large scales on the fore part of his legs assume a beautiful deep rose-color, looking as if they were made of fine pink coral; and in some cases the skin of the head and neck becomes red too. The North African or Bethany ostriches have bright red thighs, head, and neck, are much handsomer than the Cape birds; and their feathers, being larger and softer and having longer filaments, command higher prices.

Ostriches are extremely nervous and subject to panics, under the influence of which they will run immoderately, often till they are lost. At plucking-time they are driven in from all the corners of the farm whither they have wandered, and collected first in a large inclosure, then in a small one, the plucking-kraal, in which they are crowded together so closely that the most savage bird has no room to make himself disagreeable. Besides the gate through which the ostriches are driven into the kraal, there is an outlet at the opposite end, through the "plucking-box." This is a firm wooden box, in which, though there is just room for an ostrich to stand, he can not turn round or kick. At each end is a stout door, one of which opens inside, the other outside, the kraal. Each bird in succession is dragged up to the first door, and, after more or less of a scuffle, is pushed in and the door slammed behind him. Then the two operators, standing one on each side of the box, have him completely in their power; and, with a few rapid snips of the shears, his wings are denuded of their long white plumes. These, to prevent their tips being spoiled, are always cut before the quills are ripe. The stumps of the latter are allowed to remain some two or three months longer, until they are so ripe that they can be pulled out—generally by the teeth of the Kaffirs—without hurting the bird. It is necessary to pull them; for the feathers which, by their weight would have caused the stumps to fall out naturally at the right time, are gone. Some farmers, anxious to hurry on the next crop of feathers, are cruel enough to draw the stumps before they are ripe: but Nature, as usual, resents the interference with her laws, and the feathers of the birds which have been thus treated soon deteriorate.

After a good rain, ostriches soon begin to make nests. The males become very savage, and their note of defiance—*brooming* as it is called by the Dutch—is heard in all directions. The bird inflates his neck in a cobra-like fashion, and gives utterance to three deep roars, the first two short and *staccato*, and the third very prolonged, the whole being described as identical in sound with the roar of the lion. When the birds are savage, or *quei*, as the Dutch call it, they become very aggressive, and it is impossible to walk about the camps unless armed with a weapon of defense called a *tackey*. This is a long and stout branch of mimosa, with the thorns all left on at the end. "It seems but a feeble protection against a foe who, with one stroke of his immensely powerful leg, can easily kill a man; the kick, no less violent than that of a horse, being rendered infinitely more dangerous by the formidable claw with which the foot is armed." Those, however, who are well practiced in the use of the *tackey* have no difficulty in dealing with the most furious bird. They thrust the thorns in his face, and he shuts his eyes and is bewildered, and the man goes on. Fortunately, one is never assailed by more than one ostrich at a time; for, in the large camps, each one has his own domain, separated from those of the others by some imaginary boundary-line of his own, within which he defends his claims with vigor. Any other ostrich daring to invade his territory is at once attacked, and the human intruder is carefully looked out for till he is seen safely away. Immediately after thus speeding the parting guest, the most savage bird is quite harmless; he dismisses you from his thoughts, and walks quietly back, feeding as he goes. And in the distance you see the head and long neck of his neighbor, whose kingdom you have now entered, and whose sharp eyes spied you out the instant your foot crossed his frontier. He now advances toward you with jerky, spasmodic movements, as if he were bowing you a welcome; this, however, is far from his thoughts, and, after sitting down once or twice to give you his challenge—whereby he hopes you will be intimidated—he trots up defiantly, and the *tackey's* services are again required.

Thus, during a morning's walk through the camps, you may be escorted in succession by four or five vicious birds, all determined to have your life if possible, yet held completely in check by a few mimosa thorns. When an ostrich challenges, he sits down, and, flapping each broad wing alternately, inflates his neck and throws his head back, rolling it from side to side, and with each roll striking the back of his head against his bony body with so sharp and resounding a blow that a severe headache seems likely to be the result. A person on horseback is even more obnoxious to the ostriches than a pedestrian; and a ride through the camp enables one to realize how true to life is the description in the book of Job of a vicious bird: "What time she lifteth herself on high, she scorneth the horse and his rider." The creature, when preparing for an attack, draws itself up, stands on tiptoe, stretches its neck to the full extent, and really seems to gain several feet in height. The birds are very uncertain in their affections, and take sudden and unaccountable dislikes; and they are sometimes so vicious that the herdsmen have to kill them in self-defense—and as this usually happens with the finest ostriches, with considerable loss to the proprietor. Mrs. Martin had an opportunity of witnessing from her window the regularity with which a pair of birds, sitting alternately on the eggs, came on and off at their fixed times. "The cock always takes his place upon the nest at sundown, and sits through the night—his dark plumage making him much less conspicuous than the light-colored hen; with his superior strength and courage, too, he is a better defender of the nest against midnight marauders. At nine in the morning, with unfailing punctuality, the hen comes to relieve him and take up her position for the day. At the end of the six weeks of sitting, both birds, faithfully as the task has been shared between them, are in a very enfeebled state, and miserably poor and thin." There was one hen which refused to sit, and compelled her mate to do all the work; but at the next nesting the cock gave her a sound drubbing and brought her to terms. Of another couple, the hen suffered an accident and had to be killed. Her mate mourned her long and refused to accept any other spouse; and when the period of mourning was over, and he took another mate, he allowed her to tyrannize over him and keep him in abject fear. The hen ostrich lays every other day; and if, for each egg laid, one is taken from the nest, she will continue laying till she has produced twenty or thirty. If no eggs are taken away, she leaves off laying as soon as she has from fifteen to twenty. Every morning and evening the nest, or shallow indentation in the ground, is left uncovered for a quarter of an hour, to allow the eggs to cool. The sight of nests thus apparently deserted has probably given rise to the erroneous idea that the ostrich leaves her eggs to hatch in the sun. But, "stupid though she is, she has more sense than to believe in the possibility of the sun hatching her eggs; she is indeed quite aware of the fact that if allowed to blaze down on them with untempered heat, even during the short time she is off the nest, it would be injurious to them; and, therefore, on a hot morning, she does not leave them without first placing on the top of each a good pinch of sand." The charge made against the ostrich's intelligence that, hiding its head in the sand, it imagines itself to be invisible, is declared to be false; but it does other things as foolish, and is well described in Job's words, "Because God hath deprived her of wisdom, neither hath he imparted to her understanding." Ostriches are long-lived creatures, and, however old they may become, they never show any signs of decrepitude, nor do their feathers deteriorate. Their career is usually ended by some accident: "and in about ninety-nine cases out of a hundred the disaster is, in one way or another, the result of the bird's stupidity. There surely does not exist a creature—past early infancy—more utterly incapable of taking care of itself than an ostrich; yet he is full of conceit, and resents the idea of being looked after by his human friends; and when, in spite of all their precautions for his safety, he has succeeded in coming to grief, he quietly opposes every attempt to cure his injuries, and at once makes up his mind to die." The worst and most frequent accidents by which they suffer are broken legs; and their legs are exceedingly brittle. This necessitates the crippled bird being killed, for it admits of no remedy.

At last, the family had to return to England; and, although there were not many human friends to take leave of, "there were plenty of good-byes to be said; for those who live on these out-of-the-way farms come to be on very intimate and familiar terms with their live stock; and all our creatures—even the fowls, and those tamer members of our large family of ostriches which for years had been daily looking inquiringly in at our windows, and picking and stealing round the kitchen door—were very old friends, from whom we were sorry to part." Strange to say, the animals the parting with which excited the least painful feeling were the horses. The independence and freedom of their lives make them indifferent to human society, and there grows up none of that fellowship with them that is universal between Europeans, Asiatics, and American Indians and their horses.

DRESS AND ADORNMENT.

II. DRESS.

By Prof. FREDERICK STARR.

WHY has dress been developed? We answer at once, to serve as a covering to the body. But, if we think over the matter a moment, we shall see that three different motives may have operated:

1. The desire for ornament.
2. The wish to protect one's self against weather and harm.
3. The feeling of shame.

Dress may, then, be a decoration, a protection, a covering. All three of these motives have no doubt acted, but we believe the first has been the earliest and most powerful.

Were modesty and the feeling of shame the only factors in urging on dress development we should expect to find no naked races; there should be an inflexible rule as to what constitutes modesty, and covering should always be more important than display. In reality we find the opposite of all these. "What is necessary is always less important than luxury." Ornament is never lacking—clothing often is. Peschel has somewhat fully discussed this matter of nakedness and shame. He tells us that there are tribes who, when first discovered, lived naked. Among those he names are Australians, Andamanese, some White Nile tribes, the red Soudanese, Bushmen, Guanches, some Guianians, Coronados, and the Botocudos. All these people, dwelling in a state of nudity, seemed to have no idea of shame on that account. The feeling of shame for nudity is not then universal, nor have we any reason to believe that it ever was.

It is true that all these tribes are dark-skinned people, and it is claimed by some writers that a dark skin lessens the realization of nakedness. Adolph Bastian said that his "skin appeared abnormal and by no means beautiful by contrast" with that of the dark peoples he met. Jagor said of a King from Coromandel who wore only a turban and a waistcoat, "He did not look indecent, for his dark color almost removed the impression of nudity." At Yuma, Arizona, the Yuma Apaches flock to the passenger trains and are looked at with great interest by the tourists. We have been profoundly impressed with the absolute insensibility of these ladies and gentlemen to the fact that the Indians are really almost naked. That a dark skin does lessen the feeling that a man looked at by a white observer is naked is certain. That it lessens in any degree the dark man's own perception of the fact is doubtful.

In developing the subject still further, Peschel states that there is no fixed standard for shame on account of bodily exposure. Of what one is ashamed varies with race, with style of dress, and with fashion. "The Mussulman of Ferghana would be shocked by bare shoulders at a ball; an Arab woman does not expose the hair on the back of her head, nor the Chinese woman her bandaged foot." An early traveler describes an Australian woman who wore bands of shells about her head and arms and a cord of human hair about her waist. Without this cord she felt shame; yet it was not in the least a protection or covering. Humboldt, in speaking of skin-painting among some South Americans, says, "Shame was felt by the Indian if he were seen unpainted." In these two interesting cases we strike the key-note of the whole subject—"it is the absence of the customary that causes shame." To use a homely and not original illustration among ourselves, a man who forgets his necktie and goes to business without it, on discovering its absence feels a chagrin and uneasiness quite out of proportion to the importance of the matter. We see that shame for nudity is not universal, that the standard of decency in covering the body varies, and that the feeling of shame seems to arise from the absence of what is customary. It seems to us, from these facts, that the idea of clothing as a modest covering is relatively recent, and that it is subsequent to dress development.

Nor does it seem that protection has been the chief factor in dress development. The Fuegians went almost naked even in bad weather; "a small square of skin hung over one shoulder and was simply shifted to windward." On the other hand, clothing has been developed to a very elaborate extent in many regions where the climate does not at all compel its use.

The third of the three motives mentioned remains. Dress has generally developed out of ornament. That it has, after being developed, often been turned into a modest covering and a protection is unquestioned. No people are without ornaments; many are without dress. Ornaments are of two kinds—those directly fixed into the body, and those which are attached by a cord or band. As soon as man hung an ornament on such a band, dress evolution had begun. Lippert calls attention to the fact that some parts of the body are naturally fitted to support bands or girdles; they are the temples, neck, arms above elbow, wrists, waist, legs above knee,

FIG. 1.—AFRICAN APRONS, WRAPPED FOR STORAGE.

ankles. There are girdles and bands of an ornamental character and in the greatest variety for all these parts. They will be described and illustrated in our next lecture. Nothing is more simple than the passage of a cord about some one of these places, and the hanging upon it of objects supposed to be beautiful.

Two of these ornament-bearers would be capable of carrying a particularly heavy load of objects. These are the neck and the loins girdles. To what extent the hanging of ornament upon these girdles is carried is shown by the following cases mentioned by Wood. A young Kaffir dressed for a visit is described as follows: "He will wear furs, among them the Angora goat; feathers in his head-dress; globular tufts of beautiful feathers on his forehead or on the back of his head; eagle feathers in fine head-dresses, as also ostrich, lory, and peacock feathers. *He ties so many tufts and tails to his waist-girdle that he may almost be said to wear a kilt.*" Of some other Africans—"Around their waists they wear such masses of beads and other ornaments that a solid kind of cuirass is made of them and the center of the body quite covered with them." In these cases, which might easily be multiplied, is it not evident that the objects hung on to the girdle are simply ornamental, and

Fig. 2.—Southern Type of Dress. Loochoo Islanders. The hair-dressing is ethnically characteristic.

that one accustomed to wearing such a mass of objects would feel shame at their absence? This ornamental mass would, with introduction of newer and lighter materials, give way to an apron which would be really a modest covering, although originating in ornament. The African apron and the Polynesian *liku* are developed from the waist-cord with its ornaments. In the same way the neck-girdle might give rise to a cape for the shoulders.

Examining the dress of the world, we can distinguish two fairly marked types which we may designate, as Lippert does, the northern and southern types of dress. The latter is really a development from just these two pieces of dress—the neck-girdle and the loins-girdle. It has originated in and is adapted to warm climates, it is loose and flowing, it has evidently originated in ornament. It is the dress of China and Japan, of the Orient, of ancient Greece and Rome, and of old Egypt. No matter how elaborate the style or how beautiful the material, such dress may all be reduced to the two simple articles before mentioned. The northern type may have been largely due to the wish for protection against the cold, although even here the ornamental has not been lacking in influence. Perfectly developed, the type presents us close-fitting jackets and trousers with tight sleeves and legs. The first materials for this type of dress were skins, and the form of the garments is doubtless due to the fact that the skins were at first tied with thongs about the limbs and trunk. We have said that even here we find the influence of the strife for display. We believe skins were first worn as trophies. Frequently in the classics the heroes are described as wearing skins of lions or leopards. In Egypt, Diodorus says the king wore a lion's, dragon's, or bull's skin over his shoulder. In a severe climate such trophies would become protective coverings. The forms of southern dress were developed by draping, those of the northern by wrapping; but, as the body draped and wrapped was the same, we need not be surprised at finding somewhat similar garments in both series. Jackets and trousers are worn by both Chinese and Eskimo, but in the one they are loose-fitting, flowing garments, in the other close-fitting and tight.

Fig. 3.—Northern Type of Dress. Eskimo.

It is most interesting to see how, after the idea of dress was once developed, it has stimulated man's mental progress and mechanical skill in searching for better materials for clothing and devising means of using them. Let us briefly consider some of these dress materials and the ways in which they are treated to render them fit for use. Skins were employed early and are in use the world over. Schweinfurth, in speaking of his Niam-niam guides, says: "They wear large aprons, like cooper aprons, in the early morning, as a protection against dews and dampness. None of these skins are more beautiful than that of the bushbok, with its rows of white spots and stripes upon a yellow ground. Leopard-skins are worn by chiefs only." Of the Bongo the same author says that they "simply knead and full by ashes and dung the skin for their aprons, etc.; they also apply fat and oil until the skins are pliant." Kaffirs, we are told, invite friends to help them in dressing skins. The party "sit around the skin and scrape it, carefully removing all fat and reducing the thickness. They

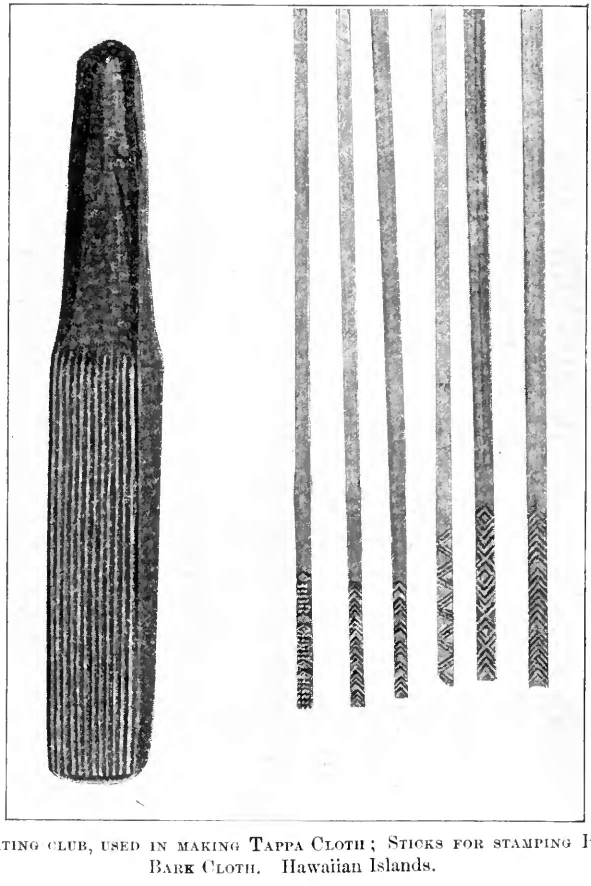


Fig. 4.—Beating club, used in making Tappa Cloth; Sticks for stamping Patterns on Bark Cloth. Hawaiian Islands.

then work it all over by pulling and stretching it over their knees. When completely kneaded each takes a bunch of iron skewers or acacia thorns and revolves the bundle in his hands, points downward, on the skin, to tear up the fibers and add pliancy and raise a fine thick nap. Powder of decayed acacia stumps is then rubbed into the skin with the hands. A little grease is then carefully rubbed in." The beautiful buckskin which our own Indians make is well known. The skin is soaked in a lye of wood ashes for some time. It is then stretched and pegged out, the hair scraped off, and brains of deer rubbed in. Among the Eskimos we find some very handsome garments made of bird-skins. These, as other skins, are softened by being chewed between the teeth. These various cases interestingly show the beginnings of tanning.

Nature offers ready-made garments in leaves, and, where modesty *is* the motive to dress, we find them used. In New Caledonia men wear a single leaf hanging from a girdle, and in New Guinea a belt of leaves or rushes five inches wide and long behind. Kingsmill women wore a long rope of human hair two hundred to three hundred feet long, to which was hung a dress of leaves. Very interesting is the fact that at Madras, once a year, the whole low caste population put aside their ordinary garments and wear leaves. Later we shall refer to this instance again.

Nature is not always so kind as in Brazil, where, Tylor says, a man who wishes a garment goes to a *shirt tree.* He cuts a four or five foot length of trunk or large branch, gets the bark off in an entire tube, which he has then to soak and beat soft and cut slits in for arm-holes. A short length makes a woman's waist. But bark is used as a dress material widely. Throughout a large portion of Oceania the natives have their *tapa, masi,* or *gnatoo* cloth, made by beating the bark of the malo tree. Wood quotes the process of manufacture of the *gnatoo*:

A circular incision is made around the trees near the roots with a shell, deep enough to penetrate the bark. The tree is then broken off. It is left in the sun for a couple of days to become partly dry, so that the inner and outer bark may be stripped off together without leaving any of it behind. The bark is then soaked in water for a day and a night, and scraped carefully with shells, to remove the outer bark, which is thrown away. It now swells and becomes tougher. Being thus far prepared, beating (*tootoo*) begins. This is done by a mallet a foot long and two inches thick, two sides horizontally grooved a line in depth, with intervals of a quarter of an inch. The bark, which is two to three feet long and one to three inches broad, is then laid on a beam of wood six inches long and nine inches broad and thick, which is separated from the ground about an inch by bits of wood, so it may vibrate. Placing the bark before her, the woman beats with her right hand, and moves the bark to and fro with her left, so as to beat it evenly, using the grooved side of the mallet first and then the smooth one. Women generally beat alternately and early in the morning. In about half an hour the material is beaten sufficiently thin, and has spread so much laterally as to be square when folded. They double it several times during the process, so as to spread it more equally and to prevent breaking. Thus prepared, it is called *fetage.* The second part of the operation is called *cocanga,* or printing with cocoa. The berries of the *toe* are gathered—the pulp of which makes a paste. The root of *mahoe* is sometimes used. The soft bark of the cocoanut is scraped off and yields a reddish-brown dye. A stampis made of dry leaves of the *paoonga* sewed together so as to be of sufficient size, and afterward embroidered with cocoanut-husk fiber. These stamps are generally two feet long by half a foot broad. They are tied into

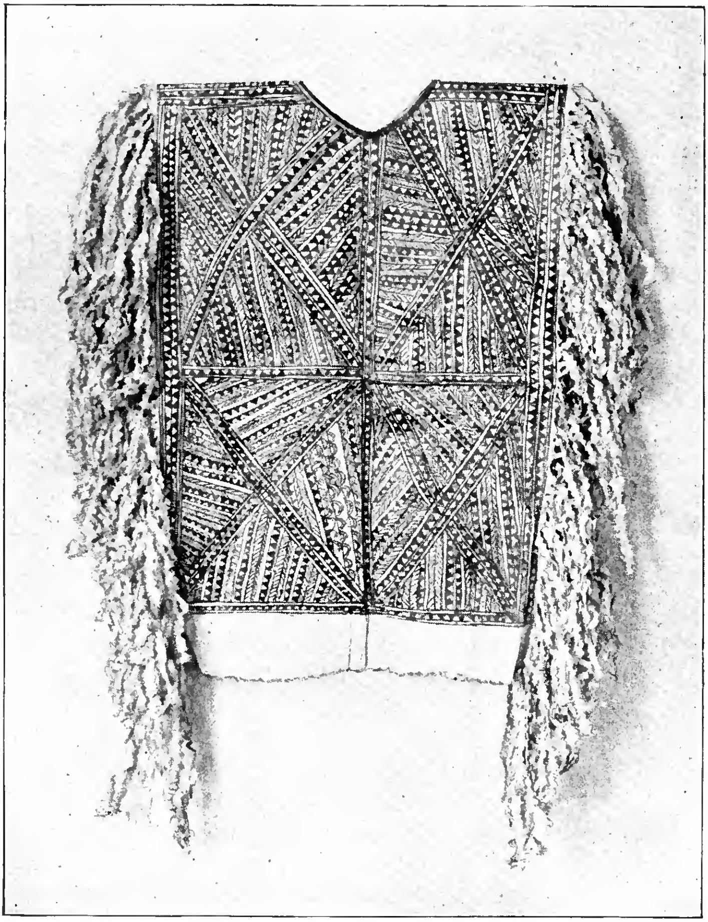


Fig. 5.—Garment of Beaten Bark. South Sea Islands.

the convex side of cylinders of wood six or eight feet long, with the pattern side up. The bark cloth is laid on and smeared over with a piece of *gnatoo* dipped in dye. Another piece of the *gnatoo* is laid over the first, so as not to exactly match it. Both are pieced out in all directions, and three layers are built, each being stained separately. The process is continued until a piece six feet broad and forty or fifty yards in length has been printed. This is folded and baked under ground, to harden and darken the dye, also to deprive it of the smoky smell due to cocoa. When thus exposed for a few hours, the cloth is spread on grass or sand and the operation of *toogihea* begins—stamping it in certain places with the juice of *hea,* which constitutes a brilliant red varnish. This is done in straight lines, along the junctions of the printed edges, and serves to conceal irregularities. It is also done in other places in the form of round spots an inch and a quarter in diameter. Exposed to dew, and next day to the sun, it is packed for future use. When not printed or stained the cloth is called *tapa.*

Schweinfurth describes the *urostigma* of the Monbuttos, which is used much as the shirt tree of the Brazilians. He says that nearly every house has its trees, which need cultivation. He states that the removal of the bark does no harm to the tree, and that a new growth is ready in three years. He adds the interesting fact that this bark cloth is the common dress, and that *skins are worn only when in fancy dance dress.* The significance of this we shall see later.

Fig. 6.—South Sea Islander with Dress of Bark Cloth.

Besides tanning, beating bark, and felting hair, the search for dress materials and study of their use have given rise to the art of weaving. This art begins in basketry and plaiting, Seldom at present do we find plaited dress articles. Wood, however, mentions some of interest. In the lower Murray region of Australia a circular mat (*paringkoont*) made of reed ropes coiled and bound together by fibers of chewed *bulmol* is worn. It is simply folded about the body and tied at the waist. In New Zealand the native wild flax supplies a wonderfully fine material for plaiting. It is fully utilized, and nowhere do we find more elegant mat garments. Wood describes several kinds.

A mat may be made of *phormium* leaf cut into strips an inch wide, each alternate one being dyed black. Each strip is divided into eight little strips or thongs plaited into a checker-work. Other styles of "mats" are made of *phormium.* The fibers of the leaf of this plant are strong, fine, and silky. A weaving-frame on sticks a foot or so from the ground is used in making some of these mats. Upon it is a weft of strings close together and drawn tight; the weft is double, passed under and over each yarn. A bone beater is used. Even a common mat takes eighteen months in making. All mats are ornamented with strings or tags: thus, one was covered with long, cylindrical ornaments, looking like porcupine-quills, hard, alternately yellow and black. These are made of phormium-leaf epidermis rolled up. The *kaitaka* is a peculiarly beautiful mat, soft and fine, plain except the border, which is in some cases two feet deep, elaborately woven in Vandyked patterns of black, red, and white. War cloaks of chiefs are woven in much the same way, but hair is woven in so that the mat looks like a skin. Such cost four years' labor, and no two are alike.

Fig. 7.—Monbutto Warriors with Dress of Urostigma Bark. (Schweinfurth.)

Out of such plaiting as this true weaving grows. The only difference between plaiting and true weaving is that the splints or ribbons of the one are replaced by cords or threads. The development of the great looms of to-day has been often enough traced. A good example of their beginnings is the very simple little wooden *cibohikan* of our Sacs and Foxes.

Some of the articles of dress made by savage and barbarous peoples deserve notice. They are sometimes elegant in material and beautiful in workmanship. No furrier can do better work than does the Kaffir *kaross*-maker.

A large *kaross* is worn fur inward. If made of several skins, the heads are in a row along the upper margin. This is bent back and falls outward as a cape. Jackal-skin is prized as thick and soft, with rich black mottlings. That of the meerkat is also valued. One *kaross* of thirty-six skins was sewed very neatly;

each skin was pierced by a weapon; yet, viewed on the hairy side, not a hole is visible, circular pieces of skin being "let in." Great skill is shown in selecting these pieces, as the meerkat is extremely variable. A professional *kaross*-maker takes two pieces of fur, places them together, hairy sides in and edges just matching. He repeatedly passes the long needle between the two pieces, so as to press the hair downward and out of the way. He then bores a

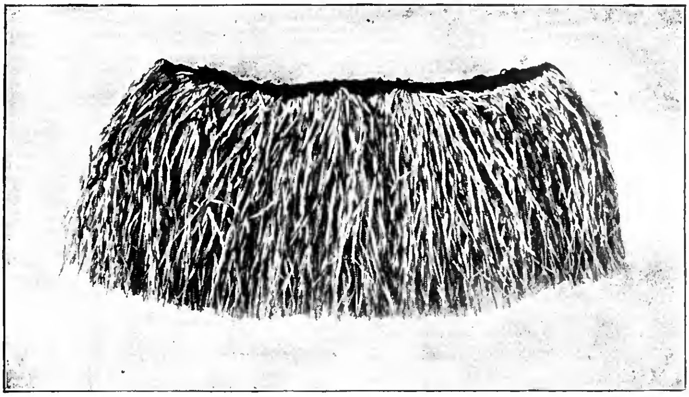


Fig. 8.—Liku. South Sea Islands.

few holes in a line with each other and passes a sinew fiber through them, casting a single hitch over each hole but leaving the thread loose. Two or three such holes being made and the thread passed through, he draws it tight so as to produce a sort of lock-stitch, perfectly safe and neat. Finally, he rubs down the seams so that the edges lie as if one piece. The gray jackal is more prized than the black; though not so beautiful, it is more rare. One *kaross*, five feet three inches deep by three feet wide, was made of several skins. The skin is darkest along the back. The maker has here selected skins and uses the darker ones for center and lets it fade away toward the edges to give the effect of one large skin. Not only so, but by careful cutting and piecing the effect was carried out. All the heads are set in a row along the upper edge. The lower edge is made from the skin of the paws—*very* dark, in a stripe four inches wide. In some *karosses*, two feet from the top and on the outer edges, are small wings or projections, one foot long by eight inches wide. These wrap around the shoulders and arms. The *kaross* reaches the knees in front and a foot lower behind and at the sides. The edge of the *kaross* is bound on the inside with membrane band to add to its strength. This is made from antelope-skin, rolled up and buried in the ground until partly putrefied; it is then split. The needles used are like skewers and eyeless. The thread is of sinews—the best of which are from the neck of the giraffe. Naturally, these are stiff, angular, and elastic. When wanted for use it is steeped in hot water until quite soft, and then beaten between stones. This separates it into filaments of any fineness and *very* strong. The sinew is used wet and so is the leather; when dry, the seams are very tight and close (Wood).

The Kaffir also wears an apron called an *isinene*. This is simply a waist-girdle to which are hung trophies. Though these are supposed to be tails of the leopard, lion, or buffalo, they are seldom really such. One specimen was made up of fourteen tails of twisted monkey-skin, each about fourteen inches long, finely sewed to a belt of the same material covered with red and white beads. Across the belt were two rows of brass buttons. Among the Polynesians the common dress is the *liku*, a fringed girdle of thongs of some vegetable material. These thongs may be of no greater coarseness than pack-thread, or they may be of some width and neatly crimped. Feather garments are frequently of great beauty. The finest come from South America and the south seas. A Munducuru apron consisted of a backing of cotton string into which were worked feathers: a band of jetty black at the lower end, above it bright yellow, and then scarlet with blue and yellow pattern in it; the upper edge was set with brilliant beetle elytra. The most famous feather mantles were those made for royal use in Hawaii, consisting of mesh-work into which were worked feathers of the yellow melithreptes. Only two of these feathers were produced at one time by one bird, and the mantles were valued at an almost fabulous price. Last of these descriptions we may quote what Schweinfurth says of the costume of King Munza, of Africa, on state occasions. He wore a plumed hat on top of his chignon, reaching one foot and a half above his head. This hat was a narrow cylinder of closely plaited reeds, ornamented with three layers of red parrot feathers and crowned with a plume of the same; it had no brim; he wore a copper crescent in front. His ear muscles were pierced, and

Fig. 9.—South Sea Islander with Liku.

copper bars as thick as the finger were in the cavity. His body was smeared with powdered camwood. His garment of a large piece of fig bark, stained with camwood, reached in graceful folds down the body. Round thongs of buffalo hide, with heavy copper balls at the ends, hung around his waist in a huge knot and, like a girdle, held the coat, which was neatly hemmed. Around the neck hung a copper ornament with little points radiating like beams over the chest; on his bare arms were pendants, in shape like drumsticks, with rings at the end. Half-way up the lower arms and below the knees were three bright, horny-looking circlets of hippopotamus-hide, tipped with copper. In his right hand was a sickle-shaped scimiter of pure copper.

A piece of suitable material for a garment having been secured, the forms would be easily developed. We have already suggested that the close-fitting garments of the northern type of dress arose from the tying on of skins. The present forms of the southern type are almost as simple in their origin. Tylor has suggested a development of forms from the simple blanket or skin robe. The use of the blanket itself we see among many of our Indian tribes to-day. It is simply thrown over the shoulders, grasped at the sides by the hands, and drawn about the body. If the arms are extended while one wears a blanket in this way, the garment drapes in such a manner as to suggest sleeves. Among some tribes of the Southwest there is a slit made in the center of the blanket and the head is put through this. Such a slit blanket would easily become a loose-sleeved garment, like the one so commonly in use in Guatemala and elsewhere. The Sacs and Foxes in Iowa usually wear the blanket. If a man wishes free use of his hands for work, he folds the blanket through the middle to reduce its length, and wraps it tightly about his waist, tucking the free end tightly in. It thus becomes a skirt, and though skirts usually have *not* developed in this way, they *may* have done so sometimes. However a skirt arises, the convenience of a divided skirt sometimes suggests itself, and a pair of loose and flowing trousers re-

Fig. 10.—Feather Cape and Matting Blanket. New Zealand.

sults. Thus, from girdles loaded with ornaments and from blankets worn at the shoulders and at the waist, we can see the beginnings of all the forms of the southern dress type. Curiously enough, we ourselves preserve *both* types of dress. There are two great conservative elements in society—woman and religion. Both have served and do serve to-day as useful brakes upon rash and too impetuous change. The northern and the southern types of dress once came in conflict. The time was that of the invasions of the northern barbarians upon imperial Rome. Both men and women, in the ancient days of Rome, wore southern dress. The barbarians wore the tighter-fitting garments of their colder climate. The southern man adopted the more convenient type; the woman did *not;* and so we see to-day our men in jackets with tight sleeves, and trousers fitting close, while women continue to wear in a modified form the dress of the sunny south—flowing garments, skirts, and cloaks.

Fig. 11.—Southern Type of Dress. Japan.

We have no inclination to trace the details of the history of our modern dress. In closing, however, we do wish to call attention to some "*survivals*" in our garments of to-day. The hat-band, with its bow always on the left side, is such a survival. It exists because it once had a real use, and for the position of the knot there is a reason. A hat once was simply a piece of stuff, which was held in place upon the head by binding it with a bit of cord or ribbon. This cord, of course, was tied, and in course of time the knot became large and ornamental. It was the day of sword practice, and such a cockade upon the right side would have interfered with the free use of the weapon; hence the knot must be upon the left side. The band and knot remain, though they have long been useless. Tylor shows us that the dress-coat, the ugly and uncomfortable "*swallow-tail,*" is a survival. It is really the old riding-coat. "The cutting away at the waist had once the reasonable purpose of preventing the coat-skirts from getting in the way in riding, while the pair of useless buttons behind the waist are also relics from the time when such buttons really served the purpose of fastening these skirts behind; the curiously cut collar keeps the now misplaced notches made to allow of its being worn turned up or down; the smart facings represent the old ordinary lining; and the sham cuffs, now made with a seam about the wrist, are survivals from real cuffs, when the sleeves used to be turned back."

We have tried to show that, while three motives have been influential in dress development, the desire for ornament has been the most powerful; that shame for nudeness, though sometimes acting, has been least potent; that two types of dress have been developed; and that *our* dress is a combination of these two. We have claimed that the desire for dress has urged on man's mental progress, leading to a search for materials and to development of the arts whereby they are made of service. We have considered some examples of dress of no mean workmanship made by low and barbarous tribes. We have inquired how the forms of garments came to be what they are, and have seen that in our own dress much that is useless survives from the past.

ON POLYANDRY.

By Lieutenant-Colonel A. B. ELLIS.

THE numerous examples of the forms of marriage by capture which we gave in a former paper in The Popular Science Monthly will have shown how almost universal the practice of taking wives by violence from other groups must have been in primitive times—a practice which, it may be remembered, we attributed to a prevailing scarcity of women. In the present paper we purpose showing that we were right in predicating of the primitive groups that they usually contained fewer women than men, by adducing evidence of the exceedingly wide distribution of polyandry, a system which can only be attributed to a scarcity of women; for it is inconceivable that men should have voluntarily initiated a form of marriage under which two, three, or more men—sometimes as many as seven or eight—would be the associated husbands of one woman, if there was a possibility of their obtaining a wife apiece. Even if, by doing violence to our common sense, we suppose such a thing to be possible on the part of the men, how would the women submit to a state of affairs which would compel at least three women out of every four, supposing the sexes to be equally balanced, to remain unmarried? It is obvious, however, that polyandry could in its origin only be induced by necessity. There must have been fewer—much fewer—women than men; and as experience and observation show that throughout the world the tendency is for women to be more numerous than men, it follows that, wherever polyandry exists or did exist, the balance between the sexes must have been artificially disturbed. Such a disturbance could only be effected by female infanticide, as we have already stated in our former paper.

The rudest form of polyandry is that in which the associated husbands are not necessarily blood-relations; the less rude is that in which they are brothers. The former is unquestionably the more ancient form.

The first is found among the Kasias (sub-Himalayan ranges), the Nairs (Malabar), and the Saporogian Cossacks. Apparently it was this form that existed among the Guanas (South America), for Ayasa says that among that people "careful stipulations were made as to the duties and obligations the bride undertook with reference to her husband; how far she was bound to provide him with food; whether she was to procure the necessary fire-wood; whether she was to be the sole wife; whether she was to be free to marry another man also; and in that case how much of her time the first husband wished to engage." It probably occurs at Rasaque (East Africa), for Speke mentions a case of two men having married one woman;* and it is found in the Marquesas Islands, where "no man has more than one wife, and no wife of mature years has less than two husbands—sometimes she has three, but such instances are not frequent." † In the Marquesas Islands the males considerably outnumber the females. In the Sandwich Islands the female chiefs had a plurality of husbands. Kaahumanu, one of the widows of Kamehameha, had two husbands, viz., the ex-King of Tanai and his son. A female chief named Kapiolani also had two husbands.‡ It appears that there was no limit to the number, and that the arrangement by which father and son were husbands of the same woman was not exceptional. Without insisting too much upon this instance, it seems probable that the privilege thus retained by the female chiefs was a survival from a more general polyandry; the women highest in rank being naturally those who would be able to retain it the longest.

The form in which the associated husbands are brothers has existed from time immemorial in the valley of Kashmir; in Thibet; among the Svalik Mountains; among the Spiti; in Ladak; in Kistewar and Sirmor. It is found in Gurghal, Sylhet, and Kachar; among the Coorgs of Mysore, the Todas of the Nilgherry Hills, and the Teers, Maleres, and Poleres of Malabar. It

* Discovery of the Sources of the Nile, p. 239.

† Melville's Marquesas Islands, p. 213.

‡ Journal of a Residence in the Sandwich Islands, p. 219.

is thus widely distributed in India. It also exists among the Calmucks, the Australians, and the Iroquois. Humboldt found it among the Avanos and Maypures Indians of the Orinoco, and attributed it to a scarcity of women.

Both forms exist among the Eskimos of Boothia,* and in Ceylon. Of the latter, Sirr says: † "Although when polyandry is indulged in by the highest caste the husbands are usually brothers, still a man can, with the consent of his wife, bring home another, unrelated to him, who has all the marital rights, and is called an associated husband. In fact, the first husband can bring home as many men as his wife will consent to receive as husbands, and these marriages are recognized by the Kandian laws." Sirr saw a Kandian matron of high caste who was the wife of eight husbands who were brothers. In his time polyandry was limited to the province of Kandy; but Tennant tells us ‡ that it was at one time universal throughout the island, and was extinguished in the maritime provinces by the influence of the Portuguese and Dutch. Here, too, we find that the men are more numerous than the women. By the census of 1821 the number of males exceeded by twenty thousand that of the females. In one district there were only fifty-five women to every hundred men.#

Erman tells us that polyandry exists in the Aleutian Islands, and among the Koriaks to the north of the Okhotsk Sea, but does not say which form of it. It also exists in western Eskimo Land, among the Garos of the Himalayas, and the Smerenkur Gilyaks in the southeastern corner of Siberia, but the exact form of it is left in doubt.‖

We thus find polyandry existing in the present century in each quarter of the globe. That it should exist at all, considering that the conditions which gave rise to it have almost universally passed away, and that the practice itself is manifestly to the disadvantage of the males, is a matter for surprise, and is a fresh proof of how enduring is custom. Of its existence in other localities in the past we also have direct evidence.

According to Polybius, polyandry was practiced in ancient Greece, and in the twelfth book we read that it was an old established custom in Sparta, where the brothers of a house often had one wife between them. That it existed among the Celtic inhabitants of Great Britain, the well-known passage in Cæsar proves: "Uxores habent deni duodenique inter se communes, et

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* Sir J. Ross's Narrative, vol. i, p. 335; vol. ii, p. 43.

† Ceylon and the Cingalese, vol. ii, p. 162.

‡ Ceylon, vol. ii, p. 428.

\# Heber's Journal, vol. ii, pp. 518, 519.

‖ See Journal of the Anthropological Society, London, 1865, p. cccvi; Hooker's Himalayan Journals, vol. ii, p. 273; and Lansdell's Through Siberia, vol. ii, p. 225.

maxime fratres cum fratribus, et parentes cum liberis; sed si qui sunt ex his nati, eorum habentur liberi a quibus primum virgines quæque ductæ sunt." * In the Irish Nennius we also find direct evidence of its existence. In Media, according to Strabo, in certain cantons polygamy was ordained by law, while in other cantons the opposite rule was in force: a woman was allowed to have many husbands, and those who had less than five were regarded with contempt. Polyandry receives a partial sanction in the Institutes of Menu, and it is adverted to without reproach in the epic of the Maha-bharata, the heroine of which, Draupadi, was the wife of five Pandu brothers. It existed among the Getes of Transoxiana, the Guanches of the Canary Islands, and the Caribs of the West Indies.†

Polyandry thus can not be regarded as exceptional, since we find direct evidence of its existence among so many peoples. But, as has been said, the conditions which alone could have caused it have, in the great majority of cases, passed away: the general rule is for women to be more numerous than men, and it is therefore to the survivals from polyandry, to the practices derived from it and perpetuated through custom, that we must chiefly trust for indications of its former wide distribution. Now, one of the most remarkable customs connected with polyandry is that of a brother taking to wife a deceased brother's widow, and reckoning the children born of the new union as the children of the deceased. This custom originates from the practice, in polyandrous unions, of the children always being considered the offspring of the husband who first espouses the wife. The first husband is considered the head of the household, the family property is vested in him, and all the children are feigned to be his. At his decease the brother next in age succeeds to the headship; but as the children, no matter which of the associated husbands were their true fathers, have always been reckoned the offspring of the first husband, the practice is continued, through custom, even after his death, and children born subsequently are still called his. Thus, in Thibet, the right of choosing the wife belongs to the eldest brother, to whom also all the children of the marriage are held to belong. In Ladak, when the eldest brother marries, the juniors, if they agree to the arrangement, become inferior husbands of the wife; all the children, however, being considered as belonging to the eldest brother. Among the ancient Britons the children of the wife were accounted to belong to the husband who first married her. In Ceylon, the offspring of polyandrous unions are looked upon as the children of the first husband, and that equally

* De Bello Gallico, v, xiv.

† See Humboldt's Travels, etc., vol. i, p. 32; Desalles, Hist. Gén. des Antilles, vol. i, p. 197.

whether the associated husbands are brothers, or are not related to each other. Wherever, therefore, we find the custom of "raising up seed" to a deceased brother, we are justified in holding that the people who observe it were once polyandrous. It could not be feigned spontaneously that the children born of the new union were the offspring of the deceased brother. Such a practice could not come into being unless the people who observe it had formerly passed through a phase of polyandry, and had been accustomed to feign all the children born to the associated brothers to be the offspring of the eldest brother. The following are examples of this custom:

Among the Makololo, when an elder brother dies, the brother next in age takes his wives, "as among the Jews, and the children that may be born of these women he calls his brother's also. He thus raises up seed to his departed relative." * Among the Gallas, says Bruce,† "when the eldest brother dies, leaving younger brothers behind him, and a widow young enough to bear children, the youngest brother of all is obliged to marry her; but the children of the marriage are always accounted as if they were the eldest brother's." Among the Zulus, when a son inherits his father's property, if any of his father's widows are young enough, his uncles are appointed to raise up seed to the heir's house—that is, the brothers take the wives of the deceased brother, and the offspring of these unions are reckoned as children of the deceased. This custom, called *ukeengena*, is now, however, modified, and the widow may, if she chooses, marry some other man; but, in this case, the new husband pays a certain sum in cattle to the estate of the deceased.‡ The Kirghis used strictly to observe this custom, but among them, as among the Zulus, it is now dying out; though, should a widow marry a man in her late husband's tribe, other than her brother-in-law, the man has to pay her brother-in-law a fine for the slight done him by her preferring another to himself.#

The case of the Jews must be familiar to everyone. In Deut. xxv, 5, we read, "If brethren dwell together, and one of them die and have no child, the wife of the dead shall not marry without unto a stranger: her husband's brother shall go in unto her, and take her to him to wife, and perform the duty of an husband's brother unto her." 6. "And it shall be, that the first-born which she beareth shall succeed in the name of his brother which is dead, that his name be not put out of Israel." That this was an old custom of the Jews we know from the case of Onan (Genesis, xxxviii), where, after Onan has avoided raising up seed to his

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* Livingstone's Travels in South Africa, p. 185.
† Travels, etc., vol. ix, p. 225.
‡ Incwadi Yami, p. 39.
\# Russian Central Asia, vol. i, pp. 329–330.

brother Er, and is in consequence slain, the widow, Tamar, has a recognized claim upon Shelah, the brother next in age. See also Ruth, i, where, Naomi's two sons having died, she says to her daughters-in-law, "Are there yet any more sons in my womb that may be your husbands?" and "would ye tarry for them till they were grown?" There being no brothers to take these widows, one of them, Ruth, makes overtures to Boaz, a near kinsman of her deceased husband; and this man then takes her to wife, not, however, as *levir*, but as *goël*, or redeemer of the heritage of the dead. The *goël* was not bound by law to marry the widow as a condition ,of the redemption, but it appears from Ruth, iv, 10 and 17, that when he did so the first child born of the new union was reckoned the offspring of the deceased. With the Makololo, Zulus, and others, the obligation of the levirate holds good whether the deceased had children or not; with the Jews the custom had become modified and the obligation only held good when the deceased brother was childless. This was also the case with the Hindoos at the time when the Institutes of Menu were compiled, and is the case at the present day with the Shushwap Indians of British Columbia, and other peoples.* Among the Jews, the son born of the new union, the fictitious child of the deceased brother, became the heir to the property, to the exclusion of his real father, the levir. By the Institutes of Menu the property was divided between the fictitious child of the deceased and his real father.

We have said that it is the practice in polyandrous households for the brother next in age to succeed, at the decease of the eldest brother, to the position of the head of the family, to the family property, and to the wife; and from this practice doubtless arises the wide-spread custom of a brother inheriting a deceased brother's wives. In Ladak we see that the younger brothers are not obliged to be joint husbands of the wife of their eldest brother—it is optional for them to be so or not—but the property, authority, and wife of the eldest brother devolve at his decease upon the brother next in age, whether he has agreed to the polyandrous union or not. Through the custom derived from polyandry he has a right of succession to his eldest brother's property and widow, and he can not take one without the other. In this case we see the original custom in a state of decay. In earlier times the younger brother would necessarily be a husband of the wife, and as such would, at the death of the elder brother, succeed to the position of head of the family—that is, the wife and the property would be vested in him. At the present day it is optional for the younger brother to be an associated husband, but, even if he is not one, he still

* Northwest Passage by Land, p. 319.

has the right of succession to the widow and the property. And what has occurred in Ladak has certainly occurred elsewhere. As the sexes became more equally balanced, younger brothers would prefer taking wives to themselves to being the associated husbands of their eldest brother's wife. Polyandry would die out, but the law of succession to property, stable as all such laws are, would be perpetuated through custom, and, as in the days of polyandry the heir used to take the widow with the property, so would he continue to take the two together after polyandry had disappeared.

To enumerate all the peoples among whom it is the rule for the brother to succeed to a deceased elder brother's property and wives would occupy far too much space. The custom is almost universal among the lower races, and it will be sufficient to mention a few of the most striking examples. Among the Malays, a man is not obliged to marry the widow of a brother, but if he does so he becomes liable for all the obligations of the deceased.* Here we see that to marry the widow is the counterpart of the legal right of succession to the property. Among the Afghans it is incumbent on a man to marry his elder brother's widow, and the custom is so strongly insisted upon that any departure from it is counted a scandal and a blot upon the character of the parties concerned.† Among the Shushwap Indians (British Columbia), if a man dies childless, his brother must marry the widow. In Guzerat (India), the widow of an elder brother invariably devolves upon a younger, and the law is equally imperative with the Somalis (East Africa), the Damaras (South Africa), the people of the New Hebrides, and many others. In New Zealand, Samoa, Fiji, West Africa, Mongolia, and other localities it is usual for the brother to marry the brother's widow; but if she feels any repugnance she may, subject to certain penalties, return to her own family.

In course of time, through the custom of the widow and the property always passing to the next brother, as *heir*, it becomes the custom for the heir, even when not the brother of the deceased, to inherit the widow as well as the property; and what occurs in some of these cases shows clearly that the practice is derived from polyandry. For just as the brother "raises up seed" to a deceased brother, so in some cases does the heir, even when a son, "raise up seed" to the relative from whom he inherits. Thus the Makololo chief "Sekeletu, according to the system of the Bechuanas, became possessor of his father's wives, and adopted two of them; the children by these women are, however, in

* Crawford, Dictionary of the Indian Islands, article Marriage.

† Mission to Afghanistan, p. 27.

these cases termed brothers." * That is to say, among the Bechuanas a son succeeds to his father's wives, and the children born of this new union he feigns to be the offspring of his father, and so calls them brothers. He raises up seed to the departed relative from whom he inherits. From this there can be no doubt that the custom of inheriting wives is derived from polyandry. The custom of a brother taking a deceased brother's wife is a disintegration of the older obligation of taking the wife and raising up seed; which older obligation still survives in some cases when the system of female descents has disappeared and the succession has opened to the son. The case of the Zulus is a variation. With them the son inherits the property, but the uncles take the widows and raise up seed. We thus find three phases of the system: (1) Where the succession is from brother to brother, the brother takes the widows and the property, and raises up seed. (2) Where the succession has changed to that from father to son, the son takes the property, but the brothers take the widows and raise up seed. (3) The son takes the widows and the property, and raises up seed. Finally, in all three the custom of raising up seed disappears, and the widows pass to the heir, whether he be brother or son.

Another survival from polyandry is that system of succession under which property descends from brother to brother and then to the son of the eldest brother. The system of succession from brother to brother, and then to *sister's* son, is the natural outcome of descent through females, and that from father to son is the natural outcome of descent through males; but the one from brother to brother and then to son is neither one thing nor the other. It recognizes the blood-relationship between father and son, but excludes the latter from the succession till each brother has succeeded in turn. Now this is the order of succession observed in the Thibetan polyandry: Brothers succeed one another in order of age, and, failing brothers, comes in the eldest son of the brotherhood; and the arrangement is so peculiar that we have no hesitation in affirming that, wherever this order of succession is observed, polyandry has existed.

We find this system in vogue among the Kirghiz, the Aeneze Arabs, and the Mongols; the next brother being heir even when the elder leaves issue. We have already mentioned the Kirghiz and the Mongols as observing the levirate. The same order was observed in succession to the throne of Darfour (eastern Soudan). The law was there ascribed to the Sultan Ahmed Bekr, who died about 1750; but it is less probable that it was the result of a mere enactment than that it was an established local custom. In Siam,

* Livingstone, *loc. cit.*

says Sir G. Bowring,* "on the death of a king his eldest brother succeeds; when he has no brothers, his eldest son; should he have several brothers, they succeed one another according to seniority." The levirate is optional in Siam. In Fiji brother succeeds brother, and then the succession reverts to the eldest son of the eldest brother.† It is worthy of note that all brothers are in Fiji called fathers by their nephews, just as is the case in the less rude polyandry, and that no word exists to express uncle.

Enough, however, has now been said to show how very widespread polyandry has been; traces of it are, in fact, found so universally that we are justified in regarding it as a normal phase of human progress. It can only be explained on the grounds of a scarcity of women, and that scarcity must have been felt almost universally. Hence we may conclude that we were right in our view that the early groups contained fewer women than men, and that this was the cause of marriage by capture. A number of customs which are probable survivals from polyandry lend us additional support; these we may perhaps be able to discuss on some future occasion.

THE DOGS OF ANCIENT EGYPT.

By M. G. MASPERO,

OF THE INSTITUTE OF FRANCE.

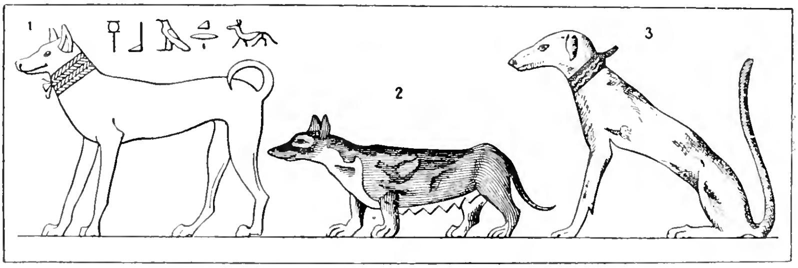
THE Egyptians domesticated the dog from the most remote antiquity. The names which they gave it—*ouhorou, ouaouou* and *tosmou*—belong to the fundamental dialect of their language; and one at least of them is a characteristic onomatopœia, such as our children instinctively use in their earliest age for the designation of the animal. It is hard now to determine what was the most ancient species they tamed; the most ancient monuments show us dogs of every size and every color, and the cemeteries have given us greyhounds, terriers, and twenty varieties more or less closely related to the jackal or to the modern fellah's dog. At the opening of Egyptian history, more than four thousand years before the Christian era, we might have met in the towns and in the country the same mixture of types and confusion of forms and colors that we observe now. The dog was in Egypt, as he is with us, a friend and a faithful servant at the same time. He lived in the house with his master, followed him in his walks, attended the public ceremonies with him, sometimes free, at others held in leash by a slave or child, or in princely families by a favorite dwarf. At meals he had his place marked under the

* Kingdom and People of Siam, vol. i, p. 96.

† At Home in Fiji, vol. i, p. 281.

benches of the guests; as in Greece and Rome, he was there to dispose of the bones, the fragments of meat, and the pieces of bread that were thrown down, and in a general way to keep the dining-room clean. These were certainly not very refined fashions, and if our house-dogs had to satisfy themselves in this way they would be likely to die of hunger. The ancients did not feel the delicate tastes and disgusts in such matters that we experience; their life presented excessive refinements and rude features of which we have no idea side by side. The house-dog in Egypt was a domestic, working at his trade, only his trade was one of those in which we have ceased to employ him; it may not have been a great thing that he has lost, but it is in the kitchen or his kennel that he finishes up his master's dessert.

The house-dog was shaved, combed, and washed; he was sometimes tinted with henna as if he were a woman; he wore fine collars on his neck, furnished sometimes with an earthenware clasp in the shape of a bell or a flower. Children played with him, became attached to him, and the hero of one story to whom his fates had predicted at his birth that he would die of the bite of a dog, willingly confronted the threatened danger rather than be separated from the dog which he had raised. He, of course, had a name, to which he answered: *Si-togai*, the son of the bat; *Akeni*, the ferreter; *Khaoubsou*, the lamp or star; *Soubou*, the



Figs. 1, 2, and 3.—Dogs from the Egyptian Monuments.

Fig. 1, one of the favorite dogs of King Antef, from his funereal stele. Fig. 2, bitch depicted in a Theban tomb of the twentieth dynasty. Fig. 3, hound from the tomb of Anna at Thebes (eighteenth dynasty), from a drawing by M. Boussac.

strong; and *Nahsi*, the black. He is seen with kings as well as with common persons. Rameses II, during the earlier years of his reign, was always escorted by a female dog which was called *Anaïtiennaktou*, or brave as the goddess Anaïtis. A petty king of the eleventh dynasty, about 3,300 B. C., had five dogs which he loved so much that he carved their names and engraved their portraits on his tomb They were, indeed, blooded animals whose names revealed their foreign origin. The finest one of them (Fig. 1) was called *Abaikarou*, a faithful transcription of the word *abaikour*, by which the hunting-dog is designated in many of the Berber dialects. A servant is holding them behind the king, who is looking at them, and prevents their disturbing the sacrificial ceremony at which they are present.

The shepherds had dogs of medium size with pointed ears, like those which still guard the flocks of Upper Egypt. Hunters sought out two or three kinds of hounds (Fig. 3), some having straight ears and short tails, and some drooping ears and a long tail, like the *slouguis* of the modern Berbers. They are to be seen in many of the tombs, springing in pursuit of gazelles and antelopes, or running down the hare and the ostrich. A few pugs, heavy and grotesque like ours (Fig. 2), are represented occasionally, rather as house-dogs than as hunters. These animals were in considerable number, and made the ancient Egyptian villages as dangerous at night as modern villages are. An officer relegated to one of the Delta burgs a few years after the death of Rameses II complained bitterly of their boldness in a letter addressed to one of his chiefs: "When, sometimes," he says, "the people of the country meet to drink Cilician beer and go out to open the bottles—there are two hundred large mastiffs and three hundred wolf-dogs waiting all day at the door of my house—every time I go out at nightfall to take part in the feast, I am kept out if I have not with me the little wolf-dog of Nahihou, the royal scribe, who lodges with me. He saves me from the other dogs. At whatever time I go, he goes with me on the street; and when he barks I run, swinging my club and whips. It is, in fact, only a pack of the mangy, high-tailed wolf-dogs prowling around the cattle-pens. When they have made their round, the largest ones in front, in a compact mass, as if in a bunch, one would say that it was the enchantment of some god, a flame which had fixed itself and would not let go." Roving dogs are less numerous and less ferocious now, but they become at times terrible to strangers. It has oftened happened to me, when casually passing through a village of Upper Egypt about midnight, to be reminded when I met them of the bull-dog in one of Dickens's novels, "a biter of man and killer of children for sport, which usually lived on the right side of the street, but also hid itself on the left side, so as to be ready to jump upon the first passer-by." As it is under Tewfik Pasha, so it was in the time of Rameses II, and the experience of the present day enables us to understand exactly what our scribe meant in the passage I have just quoted.

The dog was a god; he was at the same time several gods, of which the best known, the barking Anubis of the Latin poets, was also a jackal. As there were cemeteries for cats, there were also for dogs, where their mummies are to be found by the thousand. I am cognizant of them at Siout, Sheik Fadl, Feshn, Sakkarah, and even Thebes, and most of the Egyptian museums possess more or less well preserved specimens of them. One of these mummies was recently opened and drawn by Herr Beckmann, a German (Fig. 4). It was a small harrier, about eighteen months old. There is hardly anything left of it but the bones and the skin, and a few bits of muscular tissue between the teeth, reduced to dust. It had been wrapped in a wide band of coarse cloth glued to the skin by a thick layer of bitumen. Over this envelope they had applied a thin mat of dried reed-stems like those which are found on many human mummies of the twentieth dynasty and later, fastened by a long cord of braided grass. The animal, thus bundled up, presented the appearance of a cylindrical mass, or of a veritable basket of game, with both ends left open. A decent shape had to be given to this queer-looking package. A network of fine cloth was thrown over the part which answered to the body, so arranged as to design parallel rows of superposed squares along its length; a kind of ornament which is found on many mummies of small animals, as of the cat, ichneumons, the ibis, and the hawk. According to usage, the head was covered with a pasteboard mask, in which the physiognomy of the animal was reproduced as far as possible. It was painted a dark brown, except around the eyes, the lips, and the nostrils, which were white. The half-opened mouth showed the points of the teeth, and the ears rose above the head.

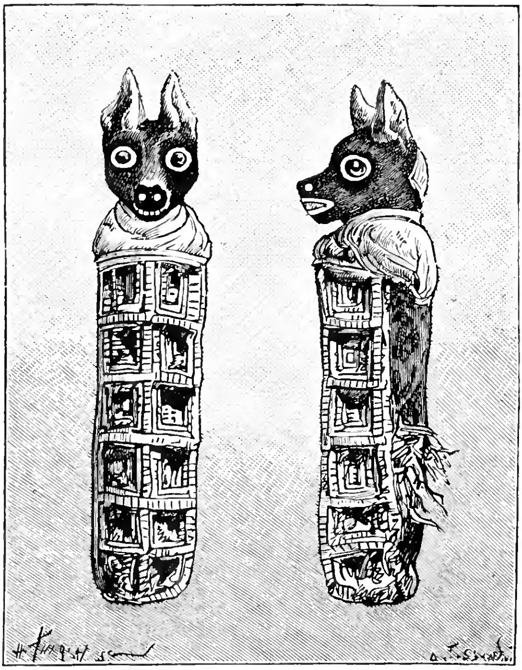


Fig. 4.—Egyptian Mummy of a Dog with Pasteboard Mask, recently discovered by M. Beckmann. Front and Profile Views.

It is to be regretted that objects of this kind have been hitherto so little studied. A small number of species of dogs have been identified from the ancient paintings, but the different naturalists who have occupied themselves with researches of this sort have not always reached the same results. The mummies would furnish them sure data, and would permit them to supplement the often deceitful evidence of the monuments. But there must not now be much delay in going into the study. European companies have been mining in the necropolises of Egyptian animals for more than twenty years. Last year a great exodus of mummified cats took place to England; and not a month passes that vessels loaded with bones and mummies of cattle, jackals, gazelles, and dogs do not sail for Trieste and other ports on the Mediterranean. When European naturalists shall at last have decided to study the mummified animals, there may not be one left in Egypt.—*Translated for the Popular Science Monthly from La Nature*

ASTRONOMICAL SOCIETIES AND AMATEUR ASTRONOMERS.

By M. L. NIESTEN.

A CURIOUS and notable fact in the history of the social condition of the present century is the disposition, amounting to a necessity, which is felt in all classes of society for organizing in groups to work in common to reach some end by the union of individual efforts which one person alone could not attain; or for forming societies. Devotees of sciences, friends of art, and patrons of letters have alike judged that, co-operating in societies, they could accomplish more and better by collecting scattered forces, and could procure in this way means for stimulating emulation and rewarding merit.

Astronomy, which has devotees and patrons in all countries, now possesses numerous societies having for their single object the progress of science, and rivaling one another in encouraging and collating the works of their neighbors, to the great advancement of knowledge of the sky.

We find the first Astronomical Society in England. Founded in 1820, it was erected into a corporation by King William IV in 1831. Sir John Herschel, son of the illustrious astronomer, undertook the preparation of the address to the friends of astronomy "It may seem strange," he said in the beginning, "that in a country like Great Britain, where science is generally carefully cultivated, and where astronomy has made great progress and drawn upon itself a large share of attention, there should exist no society occupied especially with that science; and that while chemistry, mineralogy, geology, natural history, and many other important branches of science and art are encouraged by associations which direct, by stimulating, the most energetic efforts of individual talents, astronomy, the highest branch of human knowledge, should have remained till now deprived of that powerful assistance, and have depended for its advancement only on the isolated and independent labors of individuals. Some persons may believe that astronomy has less need of this kind of assistance than other sciences, and that in the perfection which its physical theory has reached its future progress may be safely confided to the zeal of individuals and to great national establishments devoted exclusively to celestial observations, or, at all events, to those public institutions and academies which are found in all civilized nations, the object of which is the general cultivation of physical and mathematical science. For this reason it will be necessary to make known the useful objects that may be accomplished and the obstacles that may be avoided by a society devoted solely to the encouragement and advancement of astronomy."

The society organized a minute and systematic examination of the sky, dividing it into zones of moderate extent among members who had leisure and would be disposed to give particular and constant attention to those parts, in order to determine the positions and, if possible, the proper motions of all the objects, large and small, which might present themselves within their respective limits, and keep them constantly under review in such a way that not one new celestial body of cometary or planetary nature, passing their regions, should be able to escape them. The object which the new society proposed to itself was to a large extent obtained, and the progress which has been realized in astronomy during this century is intimately connected with its history. The *desiderata* which it indicated and to which it directed attention have been supplied; and while it has not taken a direct part in all the labors that have been performed, it has rendered a great service in making them known and in promulgating discoveries. There are now in England thirty-four public and private observatories. Most of these establishments have been created since 1820, under the beneficent influence of the Astronomical Society; and this is not one of the least services that it has rendered. In forming a center accessible to professional astronomers and amateurs alike, to higher minds and more modest ones, the Astronomical Society of London was the first in developing the taste for the science to the degree to which it has grown at the present day.*

The example set by the Astronomical Society of London was followed by Germany. In 1863 there was formed at Leipsic the

* The society includes now more than seven hundred members. It has published forty-nine quarto volumes of memoirs, and fifty octavo volumes of monthly notices. These two collections form one of the richest and most precious astronomical repertories.

Astronomische Gesellschaft, which, although less important than the elder society, has organized and brought to a successful conclusion some important astronomical labors. It has an international character; and one of its principal aims is to establish among the astronomers of all countries, by meetings every two years in some city of Europe, bonds of friendship and scientific confraternity.

In the General List of Observatories and Astronomers, of Astronomical Societies and Reviews,* of which M. Lancaster has just published a third edition, a special chapter is given to Astronomical Societies. We extract from it the facts that follow relative to the foundation and organization of societies created in later years. A society was founded at Chicago in 1862 for the purpose of furnishing the observatory—by the purchase of instruments, the payment of honorariums to astronomers, etc.—with the means of carrying on its work. Associations of spectroscopists and observers of luminous meteors were formed in Italy in 1871, for the publication of special works. A society was founded in Liverpool in 1882, the principal object of which was to cultivate the taste of amateurs for astronomical observations. A special amateur directs the observatory of the society, and verifies by its instruments the observations made by the members, assists his colleagues in their researches, and carries on special work in the name of the society. The American Astronomical Society was founded in 1887, and the Astronomical Society of the Pacific in 1889. The latter society, at the end of the first eighteen months of its existence, had three hundred members and possessed two funds; one for a medal to be awarded to discoverers of new comets, and another for the purchase of an astronomical library. Popular scientific societies have been formed in France since 1864, at Paris, Argentan, Marseilles, Lyons, Nantes, and Narbonne—to which each member brings his quota of work and intelligence. The Astronomical Society of Paris has been able, through the popularizing talent and indefatigable zeal of its director, M. J. Vinot, to create two hundred and one minor observatories, and to establish a circulating library of more than four thousand volumes.

The Astronomical Society of France, which hopes to rival the great societies of England and America, was founded under the

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* Liste générale des observatoires et des astronomes, des sociétés et des revues astronomiques, preparée par A. Lancaster, bibliothécaire de l'observatoire royal de Bruxelles. This collection, the several editions of which demonstrate its success and usefulness, includes a list of official and private observatories; astronomical societies; various institutions; astronomical reviews and journals; an alphabetical list, with addresses, of independent and amateur astronomers; and makers of instruments. Published by F. Hayez, printer to the Royal Academy, rue de Louvain 108, Bruxelles.

energetic impulsion of M. Flammarion. Its aim is "to bring together persons who are practically or theoretically occupied with astronomy, or who are interested in the development of that science, and the extension of its influence for the enlightenment of minds." It has now about three hundred members. The Urania Society, recently formed in Berlin, has been able by the generosity of its founders to erect a building to the purposes of Astronomy, and furnish it with the most perfect instruments. Societies of amateurs for the popularization of physical and astronomical science have been founded in Spain and Colombia, and at Nijni-Novgorod in Russia. Astronomy is no longer, in our time, the property of a few privileged persons. The public, in the whole world, has been set in the current with the facts of science by the diffusion of books written by such able popularizers as Flammarion, Guillemin, Vinot, Figuier, De Parville, and others, in France; Proctor, Ledger, and Miss Clarke, in England; and Meyer, Klein, and Wolf, in Germany; and by the announcement and familiar explanation of phenomena. At this moment, without taking account of popular scientific journals and English and American magazines, that make known the principal astronomical facts, there are twenty-nine special reviews and journals teaching astronomy to the public. There are five in Germany; six in the United States and England; four in France; and others in Belgium, Russia, Switzerland, Portugal, and Brazil.

The number of amateur astronomers is considerable, and it is safe to say that of all the sciences this is the one that can boast the most adepts among private persons. Among 1,160 astronomers now living, whose works have gained a footing in science, about half are amateurs with private observatories. In England, including official establishments and those attached to the universities, there are 34 observatories; in America, more than 80; in France, 17; in Austria, 24; in Italy, 21; in Russia, 15; and in Belgium, 5. We may say that an amateur, armed with a telescope, is to be found at every point on our planet, ready to observe a celestial phenomenon. In Chili, Honduras, Peru, New Zealand, Tunisia, and Tasmania we can meet astronomical amateurs provided with instruments, who devote their night hours to contemplating the beauties of the starry vault and to collecting observations which shall be useful for the advancement of science.

Most of the discoveries of comets, small planets, variable stars, and star-clusters are the fruit of individual researches. Were not all those amateur astronomers who, in the first ages of history, in Chaldea and Egypt, China and Mexico, drew from Nature the first explanations of celestial phenomena? From the beginning of historic time down to near our period, astronomical science has advanced only by the labors of philosophers, who pursued it as a matter of taste and not officially. Was it not as an amateur that the canon Copernicus discovered the true system of the world? As an amateur on his little estate at Woolstrop the thinker Newton discovered universal gravitation. Cavendish, who first weighed the earth, was an amateur. Belonging to a noble and wealthy English family, he devoted his whole life to the advancement of science. He was, said Biot, the wealthiest of the learned, and probably also the most learned of the rich.

Are those not also amateurs who have made the most advance in the study of the moon? Hevelius, a counselor of Dantsic, who first undertook to define the form and position of the lunar spots? To whom do we owe the details of lunar topography? To enthusiastic amateurs in astronomy—Schroeter and Lohrman in Germany, and the machinist Nasmyth in England. And now we can count by the hundred the men who give their time to observing our satellite in all its details; and a new fact is added every day to those which we already know.

The knowledge which we possess of the spots and faculæ of the sun is also derived from materials collected by amateur astronomers. We cite first Fabricius, who, living at the beginning of the seventeenth century, first observed the spots and ascertained the period of solar rotation. An amateur, also, Schwabe, of Dessau, discovered the periodicity of the solar spots, and Carrington, Warren, and De la Rue made their admirable studies on the central star of our system. Janssen found a way to observe the protuberances without being obliged to wait for the rare and brief instants of total eclipses; the musician, William Herschel, extended the frontiers of the solar republic, and radically transformed sidereal astronomy; the mathematician, Le Verrier, then a stranger to the Observatory of Paris, discovered Neptune in the depths of space, a milliard of leagues from here; and Dambouski, Burnham, and Gledhill, skilled observers of double stars, have measured the couples that move in remote parts of the sky.

We could not, if we should try, cite the names of all the amateurs who have discovered comets. It was an amateur in astronomy, Flangergues, of Viviers, who first observed the celebrated comet of 1811, the length and brightness of whose tail were the wonder of our ancestors. At seventy-one years of age this indefatigable amateur of astronomical science was so happy as to discover a second comet. Among comet-hunters, we should not forget Pons, porter of the Observatory of Marseilles, who had in France no rival as a discoverer of comets except Mersier, Director of the Observatory of Paris, whom Louis XV surnamed the "comet ferret."

Besides their activity as discoverers, amateurs have also done service to astronomical science as calculators. What a number of names we might cite of those who have given their time to the collection of observations and determining the courses which comets and the minor planets describe in space! The positions of three hundred thousand stars are now known; one third of the work of determining them has been done by volunteer astronomers. The famous catalogues of stars to which we have recourse in official observatories have been prepared in the private observatories of Wrottesley, Hartnup, and Groombridge. To produce such results, how great must have been the zeal and devotion of those amateurs who, after numerous years of watching, have been able to get together thousands of observations, with no reward except the personal satisfaction of having been serviceable to astronomy! Such labors, which are of the most ungrateful kind, and to which professional astronomers devote themselves, have no immediate result. The glory and fame which the discovery of a comet or a planet brings at once to its author are not to be found in them. They serve for the preparation of material which it is certain can not be productive for ages to come; for it is only then that these catalogues can help establish by comparison with new catalogues minute displacements of stars on the celestial vault, and can furnish the means of calculating the proper motions of these stars, and consequently of determining the direction and velocity of the movement of our solar system in space.

We need not go further in the enumeration of the various lines of progress and the discoveries that are due to private persons. We can appreciate to a certain degree the extent of the services rendered by them when we see the strongest astronomical society, that of London, distributing in fifty years more than a third of its annual medals to amateur astronomers.

Other laborers than astronomers have assisted in the advance of the science by furnishing amateurs easier means of examining the sky and bringing the greatest exactness into their observations. Among them are such men as Molyneux, Dent, Grubb, Alvan Clark, Secretan, and the clockmakers, machinists, and opticians who have placed their constructive talent at the service of astronomy. We should not forget to pay our tribute of admiration to the Dudleys, Licks, and Bishoffsheims, who have disinterestedly employed their large fortunes in constructing and furnishing observatories, and providing means to assure their existence in the future.

What emulation prevails among amateurs in astronomy! They pride themselves on cultivating the science as independent men, and spare neither time nor pains to secure a place in the legion which enrolls Copernicus and Herschel in its ranks. One can, indeed, engage with profit in those beautiful studies without making it his real profession, for means for sounding the celestial spaces are now within the reach of nearly every one. You may ask what pleasure there is in being an amateur in astronomy. I answer, Try it, and, when you have once tasted of the tree of science, you will never be able to leave it. Day and night the observer will always find subjects to study in the sky. In the daytime, the sun, its apparent motion, its dimensions, the spots on its disk indicating convulsions in its luminous atmosphere, eclipses, transits of the inferior planets, and the mysterious spectroscopic revelations of solar light offer themselves as subjects for investigation of the highest importance and the greatest interest. The hours of the night are preferred by the astronomer for his work; and he then gives himself up to his favorite occupation while others are taking their rest. A dark veil is spread over everything of active life; but above, in the sky, the curtain has risen, and a magnificient spectacle awaits the astronomer. Those thousands of stars which Newton and Galileo and Kepler and Copernicus and Ptolemy and Hipparchus contemplated, show themselves now in all their glory; they are resplendent with light, and remind us of the glory of those who discovered them or who have studied their motions. The astronomer, in view of this incomparable spectacle, is affected by a profound emotion, and feels himself growing larger before those mysteries which he has been able to sound, and he rises from his contemplation with invigorated mind.

All has changed on the earth, he says, but the sky is still the same. The plow has passed over powerful cities, extensive territories, once teeming with life and occupied by mighty nations, and the languages they spoke have been forgotten, but the stars that shone in their eyes shine for us, and the same eclipses recur, invariable in their unchanging cycles; those people observed them, and we are observing them in our turn; the same equinoxes bring the spring flowers into bloom, and the same solstices mature the harvests. The sun, moon, planets, satellites, constellations, stars, and milky way are there now as they were centuries ago, revealing their majestic beauty to the observer, and raising fold by fold the veils with which Nature has enveloped their mysteries.

Astronomy formerly held a much larger place than it does to-day in the attention of the people. In fact, as Houzeau has well said, our peoples have no idea of the necessity the men of the beginnings of history were under of referring constantly to the celestial movements. We are in the midst of so numerous clocks that no one need be ignorant of the time of day, and they are so well regulated by the aid of the meridian glasses of observatories that the masses hardly know that they require attention. Our weeks, months, and years are fixed invariably for us by the calendar; the rising and setting of the great lights, the phases of the moon, and even eclipses are in a certain way in everybody's hands, and the whole general movement of the stars is simplified for us. Ships arrive at their destination without having deviated from their route, and that by means of celestial observations so rapidly taken that the passenger hardly remarks them. All these operations, now become so simple, and of which the common man is unaware because they are made apart from him, were formerly the charge of every one. Before there were clocks to keep the hour and show it continuously, every person had to determine it every time he wanted to know it. Instead of taking the time of year from the almanac, he had to read it in the sky, the changes of which he was obliged to follow. In journeys, whether across inhabited countries or on the sea, only a few of the company could give an account of the road they had passed over or could decide upon that which should be followed. None of the professional services now placed in the hands of a few specialists existed then; every man, on the contrary, at every moment, had to be his own astronomer.

If necessity no longer provokes continuous astronomical studies and observations, and the astronomer has no reward but the pure pleasure that science gives, how comes it that astronomy, more than any other science, has created so many adepts? We will attempt to explain it. Astronomy, beyond every other science, offers phenomena which, while they are within the domain of the highest researches of philosophy, can both arrest the attention of persons having some scientific ideas and excite the curiosity of little-instructed observers. Chemistry, in its investigation of the constituent elements of the universe; physiology, in its delicate researches in the secrets of animal life; the transcendent logic of geometry enthusiastic over a formula that deters those who are not initiated—pass the comprehension of the vulgar. But the glories of the rising and setting sun, the serene majesty of the moon when it crosses the celestial vault, the mild luster of Venus, the splendor of the firmament on a cloudless night, the appearance of a comet with its long tail floating in the skies like a resplendent banner, are spectacles that can charm both the philosopher and the peasant, the mathematician who measures worlds and traces their routes, and the shepherd who sees only their figures. Further, if the object of all science is to enlarge and purify thought, to fill the mind with noble contemplations and give it a calm quiet, astronomy, from this point of view, is superior to all other sciences. No other science includes in itself so manifestly the abstractions that form the basis of our intelligence and so grand ideas of time, space, number, motion, and force.

The durations of the movements of the planets are immense. The variations presented in the periods of the stars occur by thousands of centuries. It takes light millions of years to cross the distances that separate the stars from one another. What can be said of the immensity of those worlds as compared with which the earth is but an atom, of the prodigious multitude of the suns of space, more numerous than the grains of sand at the bottom of the sea, and of those velocities with which all the stars are carried in immense whirls across the infinite ?

But you tell me astronomy is a perfect science; it has reached the height of knowledge, and there is nothing left in it for the amateur. I answer that there is always something to be reaped in the astronomical field of investigation for both the learned and the modest amateur. How many times has it not been said that all was known; and then, as the power of modern instruments was increased and new methods of investigation were invented, new conquests were made in the sidereal domain! Galileo's telescope had immense treasures to look for in the sky. In this age the improvements in the telescope have made known Uranus and Neptune and more than three hundred minor planets, with, a few years ago, the two satellites of Mars. Numerous comets and hundreds of smaller nebulæ discovered every year give additional proof that a harvest is always awaiting reapers in the sky. When we consider the immensity of the universe, how could it be otherwise ?

Analogy teaches us that the sun is one of the innumerable stars that spangle the firmament with their lights, and that each star is the center of a system like that to which we belong, and of which the sun is the center. Of all these suns, centers of planetary systems, only a few thousand are visible to the naked eye, while telescopes reveal millions of them. Then, if we consider the nebulæ—those little milky spots scattered in all the zones of the sky—if we remark that nearly all of them can, by the aid of strong optical powers, be resolved into thousands of luminous points, and that consequently they are presented to our eyes as immense milky ways investing distant universes, we arrive at the astounding conclusion that little vaporous nothings, which we can hardly distinguish with our strongest instruments, form, not a universe like our solar system, but that each of them is an agglomeration of myriads of universes, the extent and number of which can not be imagined.—*Translated for The Popular Science Monthly from Ciel et Terre.*

THE SPINNING SISTERHOOD.

By OLIVE THORNE MILLER.

NO fairy of the old tales ever conferred upon her favorite magic gifts more potent than a weapon whose slightest touch is death, and a thread becoming as needed a ladder to scale a wall, a balloon to navigate the air, a net to supply food, and a tent or a nursery for its possessor. Yet these are the common endowments of a whole family of fellow-creatures whom we —we despise.

No being that lives is more universally detested, more remorselessly destroyed, than one who exists only to serve us, whose whole life is undying war upon our most powerful enemies. Well indeed is it for us that she possesses the two magical gifts, and that, do our worst in our blind and stupid way, we can not exterminate the race—the industrious, the patient, the silent "daughter of Arachne"—the spider. Mysterious and solitary being, dumb, probably deaf, of strong though not varied emotions, with enemies countless as the leaves of the forest, who shall penetrate the secret of her life?

Is it not enough that every bird that flies, ruthlessly robs her nursery, devours her babies, and even snatches her own soft body from the very sanctum of home; that gauzy flies steal their greedy young into her nursery to fatten upon her infants; that to monkeys, squirrels, and lizards her plump body is a sweet morsel they never resist; that frogs and toads snap her up without ceremony; that centipeds seize her in resistless grasp; that wasps paralyze and bury her alive? Are not these enough, without man joining the hosts of exterminators? Man, too—in whose service she lives!

Consider for a moment her usefulness. Count, if you can, the thousands of flies and mosquitoes eaten by one common house or garden spider in a summer. Then remember her harmlessness. Other servants we must pay: birds eat our cut-worms, our caterpillars, and our potato-beetles, but we have to pay a tax—small, it is true—in fruits, in berries, in green peas, in corn; owls and hawks, while they destroy moles and mice, indulge now and then in young chickens. But the daughter of Arachne asks no reward, neither fruit nor vegetable suffers from her touch, no humming or buzzing attends her movements. Steadily, faithfully she goes on her way doing her appointed work; and we, so wise, so far above her in the scale of being, we—murder her!

Not content with that, we call her "horrid," while in truth she is a beauty, if we only had eyes to see. The largest of the family, the *Mygales*, clothed in furs, and always spoken of as "monsters," even by men of science mentioned with insulting and repulsive epithets, are seen under the microscope to be really beautiful, with every hair a plume, and the clustered eyes a crown of brilliant gems.

The most congenial home of the spider is naturally in the paradise of the insect. In the Amazonian forest with its hundreds of species, ranging from the almost invisible atom that sails off on its own magic thread, to the bird-killer with eight-inch spread of legs, we of the Western world must seek our most marked specimens. One of the silent family described by a traveler has a body like frosted silver studded with gold and emeralds, legs resembling gold wire, and a net of exquisite gold-lustered silk. Brilliant red, glowing orange, velvety black, glistening white, and other colors in combination, both charming and grotesque, distinguish some of them, while others appear in disguise. Withered blossoms, growing leaf-buds, thorns, rusty pins, sticks, bits of bark, and balls of their own silk are successfully counterfeited by one and another of this wonderful family. Many of these interesting Brazilians are unwelcome to the throat of bird and beast, by reason of spines, knobs, and excrescences of the most unique and fantastic sort. In that land of extremes also is found their most remarkable work, webs covering the whole top of a tree, with broad ribbons to hold it in place; and others so strong as not to be broken by small fruits thrown violently against them.

Intelligent, too, is our little arachnid—cunning she has been called. Many instances could be given; one of the most interesting is Belt's account of the behavior of spiders in the presence of the terrible eciton ants, which sweep the country in vast armies, and devour every living thing: "All insects and small animals recognize their relentless foe and make frantic efforts to escape. The spider alone yields not to panic, but uses common sense—may not one say reason? Some that were observed, upon the first scent of danger, took to their long legs, and having two more of them than any insect, and no inclination to stop for luncheon, soon put a long distance between themselves and the savage little hosts. Others, not caring to run, neither to be eaten, simply swung themselves out into the universe by their magic thread, and there hung between heaven and earth, like a certain legendary coffin, till the uncivil enemy had passed by. Not one was so stupid as the insects, to hide and be in a moment dragged out by the murderers whom nothing escaped. Perhaps the coolest personage on the scene was a harvestman or Daddy-long-legs, who stood on the ground right among those thirsting for the drop of blood in his round dot of a body. His legs were long, and he had eight of them, as well as a head (though one could hardly say on his shoulders). There he stood, calmly lifting up leg after leg, as an ant approached it, keeping a very sharp eye out, and never allowing one of the enemy to get near enough to touch him. Sometimes he had five legs in the air, and, if an ant came near one of the three on which he rested, he could always find space to put down one of the others to complete his tripod, while he lifted the threatened one high above the head of his tormentor—a wonderful exhibition of intelligence as well as presence of mind."

Passing under a tree on some bright morning in summer, one may chance to come upon three tiny balls on a thread of silk. They are as alike as beads on a string, and seem to be bits of rubbish wound with silk; but, like the balls of "my uncle," they are a trap for the unwary. Examine them. The upper one, easiest to reach, *is* the bundle of rubbish it looks to be; the lower one, also convenient to reach, is the same; but, touch the middle one, and out shall rush its owner, indignantly demanding by every movement what you mean by disturbing her. It is her castle, and behind its hinged door she lies in wait for the minute creatures that she eats, while enemies that would devour her on sight pass her ingenious home without suspicion.

A still more curious maker of balls "with intent to deceive" lives in New Jersey, and has been described by Mrs. Mary Treat. She constructs her balls of loose masses of her own silk, covered with bits of rubbish, even the cast-off garments of the insects she has eaten cut into atoms and scattered over them. Of these images she prepares several, fastened in a line through the web, with a vacancy for herself. The color is gray and white, and so closely do the balls resemble her that when she takes her place among them one can hardly tell which is spider and which imitation. What is strange, and proves all this to be an intentional disguise for herself, the balls are always of her own size; when she is small they are so, and as she grows she adds to her "doubles." The same policy protects her cocoons, strung along beside the queer, spider-like objects. It requires the sharp eyes of a naturalist to detect them.

If the spider is a good hater, none the less is she a warm friend. She is quite willing to be friendly with man, and many accounts are on record of her pleasant relations with prisoners. In this close acquaintance her individuality and character come out. A story is told of one who appeared to be wanting in a sense of humor (as others of her sex are said to be). She did not relish a joke, and peremptorily declined to be made game of. The relater had cultivated her friendship so successfully that she readily came to him and took flies from his hand. After some weeks of this amicable understanding he began to tease her. He offered a fly as usual, and, when his small friend came confidently forward to take it, he snatched it away. The first time she evidently thought it an accident, for, on seeing it held out again, she tried once more to take it. This time her tormentor let her get hold, and then drew it away. Even this she forgave, doubtless finding it hard to believe that her friend had become her enemy. But when he tried it a third time, the "last link was broken," the friendship at an end. She could not trust him, and the most tempting fly and the loudest buzzing appealed to her in vain. She refused to go near it, and in a day or two she deliberately abandoned her home and departed for parts unknown, probably soured for life.

Curious and unexpected traits of character were shown in captivity by two of the *Lycosas,* or running spiders, among whom—according to popular notions—are some of the most terrible of the race. The account appeared in a scientific magazine some time ago. The first member of the happy family was living contentedly in a large cigar-box with a cover of glass, accepting gratefully the fare provided, and becoming quite tame, when a second one was captured and placed in the same box, and the owner sat down to see one eat the other, the legitimate result, as he supposed, of his act. Nothing of the sort happened; on the contrary, the two seemed shy of making acquaintance. For two or three days each spider stayed on her own side of the box and made no advances, either of war or friendship, but in a week their reserve wore off and they became the best of friends. Together they ran when a fly was offered, side by side they drank from the little pool of water provided for them, and each amiably waited her turn to drink when water was given in a brush. Under this delightful and unheard-of state of things, having plenty of food and none of the work that makes the life of freedom a stern reality, they actually grew frolicsome. They chased each other around the box, playfully as two kittens; they retired to opposite corners, and then ran at each other with mouths open as if about to clinch for a fight, which the observer confidently expected to see. But on meeting each rose, stood erect on her hind feet, and laid her fore feet gently upon the head and body of her friend. Then, just as the astonished spectator looked to see them start off in a waltz, they dropped to their eight feet, ran back to their corners, and repeated the queer performance. This was a favorite amusement, with which they varied the semi-serious business of hunting flies within their small domain. They were exceedingly neat in their toilet, and after each meal every part of the body and legs was rubbed and brushed, in systematic order, and the minute heap of dust resulting carefully thrown away.

It may be thought that their refusal to justify the popular notion, and eat or be eaten, was because of their equal size or their close relationship. To test this, their keeper introduced within their box a common house spider, much smaller in size, expecting to see the vaunted bloodthirstiness which should end in the death of the intruder. How did the friends behave? They simply avoided her, as one whose ways were unfamiliar. And the stranger—did she cower in fear, or show fight? Neither. Finding herself at liberty and comfortable, she proceeded at once to business, and, when the owner of the menagerie came back after several hours, he found the new-comer had nearly filled the box with her web, while the rightful owners thereof were crowded into a corner, meekly submitting to her usurpation of their quarters.

Babyhood is almost unknown in the spider world, or at least there is very little of the helplessness of most young creatures. It is hard indeed to believe the terrible tales told by Prof. Wilder of the life that goes on in the family before the nursery doors are opened. He affirms that the cocoon of *Epeira riparia* contains hundreds, perhaps thousands of eggs, and that the doors of the silken tent are not opened for some weeks after hatching, which is a time of fearful orgies, brother and sister devouring each other, without fighting it is true, but none the less relentlessly enacting the tragedy of the "survival of the fittest." The professor thinks he is justified in his conclusions, but we can afford to wait for further proof, and not believe it until we must.

The young arachnid, whatever her cocoon experiences, comes out of that snug home with all her wits about her, and is a very knowing baby indeed. The young trap-door spider very early in life, having attained the size of a large pin's head, makes for herself in the ground a silk-lined residence, and defends it against friend and foe. The common house spider no sooner leaves the home nest than she

> "takes
> Her silken ladders out and makes
> No halt, no secret, scaling where
> She likes, and weaving scaffolds there."

The garden spider, too, begins life for herself very early, spinning a web as big as a silver quarter, and as pretty as her mamma's.

The crowning glory of this queen of spinners and weavers is her motherhood. Never was a mother more devoted. In spite of the fact that her family numbers anywhere from one to ten hundred, she wraps the eggs snugly in silk, and carries them everywhere she goes, or carefully secretes them; and she defends them with her life. Not one, from the least to the greatest, abandons the helpless infants to an ignorant nurse to be pinched or petted according to the humor of that functionary—not one!

When the babies outgrow the nursery, she opens the door and sometimes takes them all on her back, though they cover her like a blanket. Then she feeds them, either with ants or flies, which she crushes and holds while they crowd around and take lessons in what is to be their life business.

In a pleasant home in New Jersey, already mentioned, have been made some most interesting observations in spider ways by Mrs. Mary Treat. Her studies were mostly among the tarantulas, whose habit is to excavate underground residences, and to Mrs. Treat belongs the honor of discovering two new species. First is the tiger tarantula, named from the tigerish stripes of the legs, who lives in a burrow several inches deep, with a mysterious private room at the entrance, and a door skillfully designed, and covered with rubbish to look like the ground about it.

Of this family, Mrs. Treat had about thirty under observation when August came, and with it the spider's worst foe—the digger wasp. In her book Home Studies in Nature, is an exceedingly interesting account of the precautions of the wary spider and the persistence of the wasp.

Most of the spiders, wise enough to know their conqueror when they saw her, hermetically closed their doors when the raid began, and tried to remain behind their bolts and bars until the danger was over; but as it was two or three weeks before all the wasp babies were provided for, many a venturesome hermit grew hungry, opened the door a-crack, and cautiously peeped out. Alas! the caution was too late. So lively and so sharp in the hunt was the enemy, that scarcely one of these imprudent ones escaped the terrible fate of burial alive. Out of all Mrs. Treat's family only five remained to open their doors and enjoy life after the wasp war was over. This is entirely the rage of motherhood. At no other time in the year does the wasp molest the spider.

This tiger spider, in spite of her formidable name, is an exception to the customs of the family, in having a spouse as big as herself, who constructs a home, and lives as comfortably as she. In general the female spider only is a respectable member of society, the male being often a vagrant and living no one knows how, besides being undoubtedly the original of the "little husband no bigger than my thumb" in the old nursery rhyme.

The tarantula family, to which belong our New Jersey friends, is the most celebrated as well as the most maligned of the race, although most of the stories have been proved to be myths, and their accomplishments in the building line have brought them into favorable notice. America has its own specimens of the tarantula, one of which, perhaps the largest yet discovered, was found in South Carolina by Prof. Holmes, on his own plantation, and was sent with nest and young to the Museum of Natural History in Central Park, New York. This truly fearful arachnid had a body larger than a mouse and covered with hair, as well as the legs, which were short and stout. The nest was so firmly made that, although underground, it was easily lifted out of its place without injury. Indeed, it was no mere silk-lined hole in the ground; it was a regularly built house of clay packed into a tight wall, and hung with curtain of silk. At the bottom of this model residence was a small opening for a waste-pipe, so that no rain should drown the builder within her own doors.

The tarantula of the Pacific slope is of note particularly on account of her enemy, the tarantula hawk, or tarantula-killer. The spider is of large size and no coward. If a stick is poked at her, she does not run; on the contrary, she starts up that stick so promptly that no one less nimble will stay to interview her. The wasp that makes her life a burden is nearly two inches long, with brilliant blue body and orange wings. Like the more humble resident of New Jersey, her sting produces paralysis, and, when she has prepared the burrow in which to deposit the hopes of her family, she invariably starts out after a tarantula to furnish a supply of food for the egg she buries with it. Spiders have been found in this remarkable half-dead state several years after they were buried, still limber and apparently healthy.

Dr Horn, of Philadelphia, describes particularly this strange contest with the wasp. The insect flies round and round in gradually decreasing circles, while the spider stands half erect on her hind legs. Seizing the first favorable chance, the wasp dashes in and delivers a sting, instantly flying away and resuming the circle flight, till she sees another opportunity to strike. Two or three touches are usually enough to subdue the most savage tarantula. But the trouble is often not over for the plucky wasp even then. The battle may be without sound, but it is not without scent. The use of her sting is accompanied by an odor which is quickly recognized by any other wasp-mother in search of a spider. If one chances to strike it, she follows it up on the instant, and, if the spider is not underground, makes a fight for it. So furious is the battle that sometimes both of the combatants are killed.

In the West Indies the trap-door spider is appreciated and respected as a useful servant for its work in killing cockroaches, which, unless checked, would destroy their houses. It is bought, carried to the house, and cherished as we cherish a cat.

Quite the most interesting of this family is the second discovery of Mrs. Treat, which she called at first *Tarantula turricula*, or turret-building tarantula. Should one in his walks chance to notice a tiny five-sided tower rising out of the ground, elegantly made, of sticks crossed regularly at the corners in log-cabin style, and sometimes decorated with bits of moss, he would never guess that a spider was the architect. Yet such is the work of Mrs.

Treat's turret-builder, and she has not only watched the process, but has taken part in it herself.

The pentagonal structure is not the home, it is but the entrance and the watch-tower on top of which the owner delights to sit and make observation of the world about her, with sharp eye to the insect supply. The real home is a burrow several inches deep. The building of the tower is most interesting, the sticks being carefully selected, fastened in place by threads of silk, and each layer covered by a close row of small balls of earth brought up from the bottom of the cave. These balls are laid on the row of sticks, pressed flat and drawn down so as to coat the inside, and when finished, therefore, the tube is smoothly plastered. Then the silken hangings are added, and her home is complete. The towers are two and a half inches high, and are strong enough to be handled.

One builder, who allowed Mrs. Treat to assist by furnishing material, proved herself to be not only very hard to suit, but to have a temper of her own, rejecting sticks that did not please her by flinging them far off, exactly as she habitually disposed of the remains of her meals. This spider, too, lived in harmony with her mate, even in so small quarters as a glass jar. But she had her own residence, into which Mr. Tarantula Turricula might look, but was far too wise to enter. Her motherly cares and anxieties were absorbing in the extreme. The bag of eggs, large as a hazel-nut, was constantly carried about, and placed where it was warmest, in the sunshine, toward the stove, or wherever the heat was. This untiring devotion continued for two months, and when the young were out she took them all on her back.

This close student of spider ways could find no inclination in the baby to kill, much less to eat, one of its own family. She tried them with a freshly killed specimen, but the young would not notice it; and when mamma saw it she examined it carefully, then flung it away with other rubbish. She fed the youngsters by crushing a fly for them.

The most serious charge brought against our little friend is of cruelty to her kind, and especially to her spouse. It would not be surprising if a creature made and equipped for the duty of insect-hunter, and to that end filled with the "rage of killing," should now and then fail to distinguish between friend and foe; but as a matter of fact, though some species may justly be accused of coolness toward their mates, others, on the contrary, live in peace with them. It must be remembered, too, that the female spider is always under the spell of her double duty, to reduce the insects and to preserve the race. As to their relations with others, though in general spider life is solitary, there are instances of gregarious living, as well as of small spiders being not unwelcome guests in the web of larger ones. The general charge of cruelty may have arisen from the conduct of some of the *Epeira* family, one of the largest and gayest in dress, as well as the most common and widely distributed of the spider tribes.

A noteworthy member of this family found by the naturalist in the Challenger Expedition (*E. clavipes*) makes a web so strong that even birds are made prisoners by it, though whether the spider devours them does not appear. On the same expedition another was observed which possessed a more imposing residence, having by way of an upper story a globular mass of irregular threads over her horizontal "first floor." In this attic lived her spouse, a minute creature after the spider fashion of mates. Between his quarters and the parlor, where madam herself, the builder and provider, had her place, hung suspended the precious egg-bags, or nurseries, three or four in number, of different ages.

The cunning—not to say the intelligence—of the race, is shown by some in their unique method of concealing themselves from a known or suspected enemy, while remaining in plain sight all the time. It is by a violent shaking of the web, which, being extremely elastic, vibrates so rapidly as to confuse the outlines of the substantial body standing in the center and causing all the commotion. Could she have invented a more ingenious way if she had been a learned scientist?

The mania for decoration has reached, or possibly it began with, the spinning sisterhood. Dr. McCook describes some curious examples. There is the bank *Argiope*, a personage in silver drab, who makes for her own special use a white silken carpet in the middle of her large round web. From the top of the carpet reaches a ribbon of the same, and from the bottom descends a zigzag cord like the famous "winding stair" of the old song. Resting, head down, in her place, she is able to defy ordinary enemies, for she knows the trick of shaking her web until her body is absolutely invisible. Unlike many of the family, she prepares her nursery out of the house, forming a tent by lashing leaves or grasses together, and fastening securely within it a pear-shaped cocoon. This cradle, which is to swing in its airy tent all winter, is glazed outside, but within a mass of soft, silken blankets which wrap the eggs from all harm.

A near relation of this prudent mother, the banded *Argiope*, in white furry coat, decorates her symmetrical web from top to bottom with ladders of white silk. Decoration reaches its lowest form in a web described by the same observer, where the cocoons, the precious cradles of the household, are covered with cast-off shells and gauzy wings left from past and gone feasts—whether as "souvenirs" of the occasions, or to disguise the true character of the cocoon, we can only guess, for we have not got at her opinions as yet.

Perhaps the most peculiar of the web-makers is figured by Prof. Wilder, who calls the wise little spinner the triangle spider, from the shape of her snare. From the point on a twig which she selects for her resting-place, or roost, as the professor calls it, she stretches a single line a few inches, and from that point spreads four long, widely diverging lines like radii. Having done this, she proceeds to cross these cables with viscid threads like the rounds of a ladder, and, when completed about two thirds the length of the radii, the whole web looks like three distinct ladders, side by side. Everything arranged to her mind, the small architect retires to her post, the single thread from which the whole hangs, and sets her trap by drawing up the slack and holding it in a loop between her feet. In this strained position she remains for hours with the motionless patience of her race. But let a fly touch her web and she is wide awake on the instant. Her trick then is to let the loop she has held go with a snap that jerks the web and is sure to still further complicate the entanglement of the struggling fly. If this is not enough to complete his capture, she repeats the operation several times. Should he not be by this time altogether subdued, she starts down her line, drawing a fresh thread after her, cutting the old ones one after another, and, at last, as the professor says, she gathers the entire net in her hands, and throws it like a blanket over the prey. If this skillful little trapper were not a poor little half-inch-long spider, what a wonderful performance that would seem!

The triangle spider too is more amiable than some of her family in giving her mate a share of her home. According to our close observer of New Jersey, the little creature, about half the size of his spouse, lives in an upper corner of her web, apparently interested in the fly-catching business merely as a spectator. Whether he ever makes a web, and where he gets his dinners, are still unknown.

Many attempts have been made to compel the "daughter of Arachne" to work in harness, so to speak, and in consideration of food and protection to give up her silken threads for our use, as the silkworm contentedly does. Fortunately for her liberty, she is a personage of so marked individuality that no way has yet been devised competent to overcome her natural inclination to have her own way. Prof. Wilder has given much study to the subject of ways and means, and has, he thinks, perfected a plan by which one of the strong-web spinners (*Nephila plumipes*) may be trained to weave as well as to eat in our service. By this plan each spinner is to have her own home, a wire ring surrounded by water. She is to be fed with flies, which, alas! are not to reduce the hosts of the air, but to be bred for her, and every day she is to be placed in the stocks and compelled to give up her silk. This plan may possibly be feasible, but the space and the labor required would make the silk so costly that it could not compete with the product of the contented and simple-minded silkworm.

In fact, the spider, like the cat, is a self-reliant being, who will submit to petting, will become perfectly tame, so long as the friendship is reciprocal, but will never be made a slave to serve our whims. Her sturdy independence, her ability to take care of herself and to go where she pleases, were long ago recognized; for doth not the wise man of old say, "The spider taketh hold with her hands, and is in kings' palaces"?

HEARING IN THE LOWER ANIMALS.

By M. PIERRE BONNIER.

SLOW as we have been in recognizing that man owes the superiority of his form and his attributes to the experience of his entire animal ancestry, we have been prompt to attribute to other animals psychical and sensorial qualities more or less nearly identical with ours. There really seems to be some insolence in assuming that hearing, as we enjoy it, is refused to the immense majority of living beings, and especially to all the invertebrates. This arises partly from the fact that we are hardly acquainted with our own senses, and that many of our faculties are still left for us to discover while we use them in a way as constant as unconscious, and partly from our natural tendency to base on distant organic analogies functional assimilations which are far from being always admissible.

Here is a pigmentary spot to which we assign the dignity of the eye; there, a hair, an otocyst, which we call the auditory organ; and at the same time we assume that the spot is for seeing and the hair for hearing. As sight and hearing are known to us only as we have them, there results a deplorable misinterpretation of the sensorial function in animals.

Can we, however, have any conception of the power of smell of a ray or a rat? Are there not some insects which can supply the place of nearly all the other senses by the richness of their smell? And do we, aërial animals, know anything about the kind of sense of smell that water animals have?

The comparative physiology of the sight would show curious differences between us and any animal. Ants might have theories respecting luminous undulations that would seem very strange to us. Do they know what we understand by color? Do they comprehend anything but quantity and direction where we perceive light and tonality, form and perspective? Is the luminous world for them and for many other insects nothing else than a special palpitation of disturbed space which they analyze, orienting themselves in it by the perception of the force and direction of the direct or reflected disturbances? Do the handsome colors of butterflies prove that they are sensitive to the colors of flowers; and can we make sight play a certain part in the curious mimetic adaptations of different animals? Selection may serve us better than we should do ourselves without our aiding it; and it is not always by tactics that an animal escapes its enemies.

Mimicry of form and color addresses itself to the sight of the enemy, and there doubtless also exists a mimicry of odor. This, however, only proves that the enemy hears and sees without there being any calculation on the side of the interested animal. There is nothing astonishing in the thought, for we frequently meet persons to whom particular colors are unknown, and who have, therefore, only an incomplete idea of light; and if we look for sensorial memory and æsthetics behind the senses, the divergencies will be found still stronger.

Hearing, according to an opinion that appears solidly established on facts, is well developed in animals quite distant from us. Instances in point are the spider of Grétry and other spiders which seemed to have real musical tastes; eatable crustaceans, which can not be fished for successfully except in the most rigorous silence; the crabs of Minasi, which stopped in the midst of most lively frolics when a bell called them to order; the prawns of Hensen, which leaped when the slightest sound reached them; the shrimp, which exhibited in the hairs of their tails what were taken to be organs of hearing.

Dahl has ascertained similar facts concerning spiders. Romanes remarks that these insects approach instruments having a pleasant sound, and cites an observation of Reclain, who, during a concert at Leipsic, saw a spider come down a chandelier while a solo was performed on the violin, and go back very quickly as soon as the orchestra set in. He, however, expresses doubts as to the meaning of these facts; and many authors, including Lubbock and Forel, have not been able to ascertain that insects hear.

Hearing means perception of noises and sounds; and it is this perception that we refuse absolutely to every being deprived of a sacculo-cochlear apparatus. If an animal hears because certain hairs of its body are set into vibration by certain disturbances of the air, then a barley beard, a piece of velvet, and a brush vibrating harmonically, hear likewise. If we should invest the most hopelessly deaf man with a stiff-jointed armor, like the armor of the men-at-arms of the middle ages, and should put his head into a vessel capable of vibrating and trembling, he would come to a stand at the first shock like the crabs of Minasi, or would leap like the prawns of Hensen. It is not the sound that will affect him, for he is deaf, but the trepidation, which, disagreeable to a mollusk, would be intolerable to a crustacean enveloped in rigid pieces, adjusted and in contact. Nothing is more like the noise of a fly's buzzing than the sound of a tuning-fork or of soft instruments. The same flight of a fly and its energetic efforts to free itself when captured, also produce a disturbance of the air like that of the tuning-fork; what is a humming sound to us is to the spider a beating of wings.

Romanes has cited, as apposite to this subject, an interesting observation by Boys, which is very instructive, and admits of an easier interpretation than the author seems to have believed. Boys remarked that, on lightly touching with a tuning-fork a point of a spider's web, the insect turned at once to the side of the instrument, and tried the rays of its web with its fore legs to discover what was vibrating; then, coming closer and closer, reached the instrument and tried to seize it as it would have done with a fly. We know that spiders do not enjoy a very delicate sight, and that their sense of smell is not remarkable; they are accorded, on the other hand, a very fine hearing, which serves, according to the authors, the satisfaction of their musical tastes and the gratification of their carnivorous appetites. I believe, however, that they are absolutely deaf and nearly blind, but are remarkably well endowed with what we might call a sense of trembling—a sense which suffices for the needs of the immense majority of animals, and which is complicated somewhat late among the higher animals with sonorous perceptions. Sound is, in fact, like color, of recent acquisition in the animal series; it is a thing of sensorial operations that require a remarkable degree of perfection.

We have an organ, the cochlea, which permits us to appreciate fast rhythms, under the form of sensations to which we can attribute a place in a whole of continued sensorial affections of the same character, and group them in series. The spider perceives a trembling, feels the thread that vibrates most, runs along it, stops an instant at the branchings, and arrives at the point where the force, the form of tremor characteristic of this or that prey, suggest to her the instinctive and sometimes intelligent manœuvres, as we saw in the case of the tuning-fork, which will bring that prey into her possession. The same automatism studied by Fabre is observed in the spider; and the point of departure of that series of adapted acts is always the perception of a trembling.

The center of the web, the meeting point of all the radiating threads, is a veritable center of information, and the point to which the spider returns to get the right direction. Furthermore, the extreme delicacy of the threads, the tension of which is augmented by the weight of the spider, informs her of disturbances of distant origin, which are communicated only by the air and arrested by this light screen. Boys's spider glided along the thread toward the tuning-fork, as the spider did for Reclain's violin solo, and came back when Boys touched a point of the web with the tuning-fork. This experiment sufficiently explains the musical interest that led the Leipsic spider to the violin whose vibrations reached it. But at the first *tutti* or concerted crash the whole room trembled, including the web, and our spider ascended precipitately.

To a web-making spider, the regular trepidation or oscillatory vibration, which is sound to us, means simply a struggling prey to be taken; a spider placed upon a table approaches the source of a sound quite automatically. Sound, as we define it in the sense of a continued sensation, is a dead letter to it. Forel has remarked that insects continue insensible to the sound of the voice if we interpose a screen before the mouth and cut them off from the disturbance of the air. When animal nature acquires the sense of sound as the extreme limit of its perceptions it is to suffer itself to be fascinated, hypnotized, and charmed like the serpent. That continued fixed sensation is to the serpent what the fixity of its look will be to the bird which it will smite in its turn. It is an extreme perception, exceedingly troubling, and away at the extremity of physiological equilibrium, a source of sensorial inhibition, extra-cerebral.

Fishes, which have the power of orientation through the remarkable development of the canals of the labyrinth and their lateral organs directed to all points of their liquid horizon, with such susceptibility to trepidation and disturbances that they perceive the slightest, are only deaf-mutes. I have studied, in my thesis on the Auricular Sense in Space, the transformation of the sense of disturbance into a hearing sense, and the mechanism of auricular orientation in the whole animal series. I only say that all animals possessing the otolithic apparatus in any of its forms perceive, of disturbances of the medium, the intensity, the direction, and the number only, but can not convert them into continuous sensations like those we call sounds. All the experiments and observations invoked as making manifest that invertebrates have hearing only prove the perception of disturbances and tremors, more or less rhythmical modifications of the ambient medium. Of what use would be the perception of sounds in mediums where hardly any sounds are produced? The mollusk fastened to its rock recognizes the approach of a prey or an enemy; it feels the waves breaking upon it; it usually lives on a well-conducting ground, and by its foot-organ knows all that is passing there. This otolithic apparatus is admirably well adapted to give notice to the mollusk or to the insensitive armor of the crustacean of the least disturbances that pass through the mass into which it is plunged. Every one is acquainted with the experiment of the balls in contact series. A disturbance reaching the end of the chain is betrayed only by the last ball, which is free, and expends in oscillations the shock that is transmitted to it. Equally well known is the process of placing in contact with the vibrating body, plate, or membrane a light substance—sand or cork—the oscillations of which reveal a vibration which our eyes can not discover on the trembling body. In the same way every disturbance traverses the indifferent mass of the animal, and the otolith free in the otocyst, collects it, and announces the slightest shocks to the nervous tissue on which it reposes. The preotolithic formations serve in a similar way. Animals furnished with otoliths can thus analyze rhythms and disturbances which are synthetized in our cochlea into sounds of different tones. The otolithic bell can only reveal a trepidation, and continues unfit to provoke a continuous sensation other than that which results from the persistance of nervous, terminal, or central impressions, a limit beyond which it can not estimate the pitch without such an arrangement as that of the cochlear formations.

As does the spider in the center of its web, stretching with its weight all the vibrating cords that converge toward its fore legs, furnished with otoliths, so can any insect standing on slight legs, stiff and flexible at once, which draw from the ground the slightest tremblings as its antennæ do from the air, distinguish between a thousand significant disturbances, without, after all, perceiving any sensation like what we call sound.

There are, in fact, two fundamental senses which are two forms of touch. The first is immediate touch, under the form of contact when the surface of the object is accessible, or of smell or taste when it is in a state of division, in which it is revealed by its molecular atmosphere. The second touch, at a distance, which is extremely varied, comes by means of the modification of an interposed medium originating in the object that is perceived. Perceptions of electricity and heat are common to both forms.

We ought, *a priori*, to refuse to attribute to insects, whose sensorial organs are so different from ours, senses like those of man. Should not their psychology with more reason be referred to them as a class than to ours? And while it may be legitimate for man to expect to find some of his feelings among the vertebrates which have the most evident relationship with him, that inverse anthropomorphism has a curious appearance which lends our thoughts, wishes, needs, senses, and affections to beings so different from us in all respects. It would be at least prudent not to ascribe similar functions to different organs; and our language, the product of our cerebration, would be impotent to represent the emotions of an arthropod or a mollusk; for beings that differ in structure differ also in thought and instinct. The cochlea being adapted to the hearing of simple or composite sounds, tones, or noises, audition proper does not exist where there is no cochlea.

We are, in return, much less well endowed than the spider and crawfish to perceive rapid tremors and vibrations, of which we can make continuous sounds only when they exceed forty in a second.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF PROFESSOR JOHN WINTHROP.

THE name of Winthrop has always been an honored one in New England, in the domain of public affairs, and one member of the family, at least, has placed it high on the rolls of science. Several of the Winthrops of colonial times were cultivators of the sciences, but none employed such high talents so exclusively in this field of activity as did the subject of the present sketch.

JOHN WINTHROP, one of many Johns in that family, was born in Boston, December 19, 1714, and was graduated from Harvard College in 1732. His family history is a part of the history of Massachusetts. His father, Judge Adam Winthrop, was a great-grandson of the first Governor of the Massachusetts Bay Colony; a graduate of Harvard; chief justice of the Court of Common Pleas; colonel of the Boston regiment; and a lay member of the Provincial Council. Six years after graduation, John Winthrop, being then twenty-four years old, was elected to the Hollis professorship of Mathematics and Natural Philosophy by the corporation of Harvard College. The choice being submitted to the overseers of the college, that body appointed a committee "to examine the professor-elect as to his knowledge of the mathematics," which soon reported favorably. Certain of the overseers, who were especially anxious to protect the college from any possible contamination of heresy or schism, tried to have a committee appointed "to examine Mr. Winthrop about his principles of religion." This matter was debated at several meetings, but finally voted down, and Winthrop's election was thereupon approved. He was formally inaugurated, as was then the custom, January 2, 1738–'39. The ceremonies included two Latin orations, the reading of the rules to govern the professor, prescribed by the founder of the professorship, and the singing of a psalm, after which came a dinner.

Soon after entering upon his professorship, in 1740, Winthrop observed a transit of Mercury over the sun, and sent a report of his observations to the Royal Society. This paper was printed in the society's Transactions, and was favorably mentioned in the Memoirs of the French Academy. Prof. Winthrop was thanked by the society, and was asked to continue his communications. Winthrop was now launched upon a long and useful career, during which he was held in high esteem as a teacher of science at home, while his investigations won him much credit abroad. There is sufficient evidence as to his success as an instructor to justify the words of President Quincy, who, in his History of Harvard University, says of Winthrop: "The zeal, activity, and talent with which he applied himself to the advancement of these sciences [i. e., physics and astronomy] justified the expectations which his early promise had raised. As a lecturer he was skillful and attractive, and during forty years he fulfilled the duties of the professor's chair to universal acceptance." Many of his papers on astronomical subjects are to be found in the volumes issued by the Royal Society during his lifetime, among these being an essay on comets, in Latin, entitled Cogitate de Cometis, which he transmitted to the society in 1765, on the occasion of his becoming a member of that body.

On November 18, 1755, an earthquake occurred which terrified the superstitious people of all New England, who regarded it as a direct expression of the wrath of God. To calm the popular terror, Prof. Winthrop read a public lecture on the earthquake in the college chapel. He accounted for such disturbances as being produced by the expansive action of heat upon vapors contained in underground cavities, and argued ably in support of this theory. He also stated that earthquakes had occurred at intervals in New England from the time the first settlers landed, but that not a single life had ever been lost, nor had any great damage ever been done by them. In conclusion, he maintained that earthquakes are "neither objections against the order of Providence nor tokens of God's displeasure, according to the views of skeptical or superstitious minds, but that they are the necessary consequences of general laws." This lecture was published by request of the college authorities, and an account of the earthquake which Winthrop sent to the Royal Society was also printed.

At that time lightning-rods had been invented about three years, and a Boston minister published an essay in which he suggested that the use of Franklin's "iron points" might have caused the earthquake by drawing the electric fluid from the clouds and concentrating it on that part of the earth. This led Prof. Winthrop to add an appendix to his lecture in which he defends the discoveries of his friend Franklin, and shows the unreasonableness of attributing the earthquake to the action of the rods. He concludes with the hope that he has "fully vindicated the character of those innocent and injured iron points." Some years after, in 1770, he seized another opportunity to defend Franklin's invention, by publishing an essay against the notion that there was great impiety in using lightning-rods, since they prevented the "tokens of Divine displeasure" from "doing their full execution." Under date of October 26, 1770, he writes to Franklin, who was then in London, acknowledging the execution of several commissions concerning books and instruments, and says in regard to the rods: "I have on all occasions encouraged them in this country, and have the satisfaction to find that it has not been without effect. A little piece I inserted in our newspapers last summer induced the people of Waltham (a town a few miles from hence) to fix rods upon their steeple, which had just before been much shattered and set on fire by lightning." *

Prof. Winthrop had a clearer understanding of earthquake movements than the generality of scientific men of his time, and was one of the earliest, if not the first, to apply computation to these phenomena. The chimney of his house was thirty-two feet high, and, observing that bricks were thrown from it so that they fell thirty feet from its foot, he calculated the speed of their motion and found it to be twenty-one feet a second. He perceived also the resemblance between the vibrations of the earth and those of the strings of a musical instrument.

The fullest published account of the scientific work of Prof. Winthrop is contained in the chapter on Boston and Science, contributed to the Memorial History of Boston by Prof. Joseph Lovering, who for over fifty years has occupied the same professorship that Winthrop held. "Prof. Winthrop was fortunate," says Prof. Lovering, "in living at a time when he could be a witness of three celestial occurrences of transcendent importance to the progress of astronomy—namely, the first predicted return of Halley's comet in 1759, after an absence of twenty-seven years, and the transits of Venus across the sun in 1761 and 1769. In 1759 the accuracy of astronomical prediction was on its trial, and, months before the time of the expected visit, astronomers were at their posts and looking; but they were all anticipated by a Saxon peasant who first saw the comet on December 25, 1758. Winthrop saw it on April 3, 1759." He delivered two lectures on comets at this time, which were printed the same year, and reprinted in 1811. Prof. Winthrop also observed the comets of 1769 and of 1770, "one remarkable for its brilliancy and the other for the dis-

* Massachusetts Historical Society's Proceedings, vol. xv, p. 13.

turbances which Jupiter inflicted upon its orbit," and contributed accounts of the phenomena to the Boston newspapers.

Like the earthquake already mentioned, the comet of 1759 aroused considerable popular apprehension, and the following passage from one of his lectures, in which the professor essayed to calm this feeling, will serve as a good sample of his style: "It may not be unseasonable to remark, for a conclusion, that as, on the one hand, it argues a temerity unworthy a philosophic mind, to explode every apprehension of danger from comets, as if it were impossible that any damage could ever be occasioned by any of them, because some idle and superstitious fancies have in times of ignorance prevailed concerning them; so on the other, to be thrown into a panic whenever a comet appears, on account of the ill effects which some few of these bodies might possibly produce, if they were not under a proper direction, betrays a weakness equally unbecoming a reasonable being."

The transits of Venus, which were not to occur again until 1874 and 1882, were precious opportunities for astronomical work, and preparations were widely made to take advantage of them. The governor of the province, Francis Bernard, was interested in the matter by Prof. Winthrop, and sent a message to the House of Representatives, stating that the King of England had sent "a Man-of-War with Mathematicians to be stationed in different Parts of the East Indies, etc.," to observe the transit; that the French king and other powers had taken similar action, the comparison of observations taken in different parts of the earth being important, that Prof. Winthrop had offered to go to Newfoundland for the same purpose, and he therefore recommended that the House furnish the professor transportation on the province sloop, which would be sent to Penobscot a little before the time of the transit. The House of Representatives immediately passed a vote in accordance with this suggestion.

The sloop with Prof. Winthrop on board sailed from Boston May 9th, and reached St. John's thirteen days later. The professor took with him the college instruments and two members of the senior class. Some difficulty was met with in finding a suitable station, but at last a position was taken on a considerable elevation, which was afterward named Venus Hill. The work of setting up the clock and other instruments was made arduous by persecution from swarms of bloodthirsty insects, which had possession of the hill. June 6th was the day of the transit, and the weather proved favorable. In every part of America except Labrador, the phenomenon began before sunrise. At St. John's the sun rose at 4 h. 18 m., with Venus upon its disk, from which the planet passed off at 5 h. 6 m. On his return Prof. Winthrop published an account of his voyage and his observations.

When the transit of June 3, 1769, was approaching he delivered two lectures on the coming phenomenon, which were published. Dr. Maskelyne, then astronomer royal of England, desired that Prof. Winthrop should go to the neighborhood of Lake Superior, where the whole of this transit would be visible, but his health would not admit of this. Accordingly, he saw only the beginning of the passage, as at Cambridge the sun set before it was finished. Prof. Winthrop observed the transit of Mercury January 20, 1763, and prepared an account of it for the Memoirs of the American Academy of Sciences (vol. i, p. 57), of which society he was one of the founders.

As a mathematician and astronomer Prof. Winthrop had no equal in the American colonies, and his fellowship of the Royal Society, together with the degree of LL. D. which he received from the University of Edinburgh in 1771, attests his reputation in the mother-country. Prof. Lovering states that his views of the nature of heat were greatly in advance of the science of his day. His scholarship, moreover, was not limited to his specialty. He wrote Latin with purity and elegance, studied the Scriptures critically in their original languages, and was well versed in the tongues of modern Europe. "He is, perhaps," says Quincy, "better entitled to the character of a universal scholar than any individual of his time in this country." Rev. Charles Chauncy, D. D., in A Sketch of Eminent Men in New England, written in 1768, says: "Mr. Winthrop, Hollisian professor, I have been very free and intimate with. He is by far the greatest man at the college in Cambridge. Had he been of a pushing genius and a disposition to make a figure in the world, he might have done it to his own honour, as well as the honour of the college." *

The office of a professor in Harvard College during the last century was not a lucrative one. The salaries obtained were fluctuating and always small. From about the middle of the century the Professor of Mathematics and Physics received £80 a year. In reply to inquiries made by a committee of the Provincial Legislature, Winthrop wrote a letter in which he stated that his salary had been far from adequate, and that he had run in debt for the support of his family.

Prof. Winthrop married, August 22, 1746, Rebecca, daughter of James Townsend, of Boston, and by this marriage had five sons. His wife died after seven years, and he married again in 1756. His second wife was Hannah, daughter of Thomas Fayerweather, and widow of Farr Tolman, of Boston. She was the well-known correspondent of Mrs. John Adams.

The first vacancy in the presidency of Harvard College that

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* Massachusetts Historical Society's Collections, Series I, vol. x, p. 159.

occurred during Prof. Winthrop's professorship was made by the death of President Holyoke in June, 1769. Winthrop presided at commencement that year, and had he been a few years younger (he was then fifty-five) would doubtless have become president of the college. In a letter to Mr. Thomas Hollis, in England, under date of July 10, 1769, Dr. Andrew Eliot, a member of the corporation, remarks: "It is difficult to find one every way qualified to undertake such a task. Mr. Winthrop, Hollis Professor of Mathematics, will probably be the successor to Mr. Holyoke. His learning and abilities are unquestionable. He is older than we could wish, and is frequently taken off from business by bodily infirmities." The office was tendered to Prof. Winthrop, but he declined it. In 1774, when the chair was again vacant, it was offered to Winthrop a second time, and again declined.

The tide of discontent with the mother-country was now running high in the colonies, and Winthrop was clearly identified with the patriot cause. The Massachusetts Historical Society's Collections (Series V, vol. iv) contain a correspondence between the professor and John Adams. The letters cover a period within which occurred the battle of Bunker Hill, the evacuation of Boston, and the Declaration of Independence; and they show that Winthrop had a thorough understanding of public affairs, a fearless patriotism, and an eager desire for American independence. In 1773 he was elected to the Governor's Council, but, together with two other members, all having been opponents of the Government, he was negatived by Governor Gage, in compliance with a special mandate from the English ministry. Prof. Winthrop was chosen a delegate to the Provincial Congress in 1774, and in 1775 was finally admitted to a seat in the Council. About this time he was appointed Judge of Probate for Middlesex County, and held the office for the remaining years of his life. His death occurred in Cambridge, before the Revolutionary struggle was decided, on May 3, 1779.

The portrait which accompanies this sketch has been engraved from a photograph, furnished by Mr. Robert C. Winthrop, Jr., of a painting by Copley, which belonged to the late Colonel John Winthrop, of Louisiana, a great-grandson of the professor, and his last descendant in the male line.

A union of friends of astronomy and cosmical physics has been formed in Berlin for the purpose of organizing practical co-operation in these subjects in the countries of central Europe and in their colonies. Sections are formed for observations of the sun, of the moon, of the intensity and color of starlight and of the milky way, of the zodiacal light and meteors, of electrical and magnetic phenomena, and of clouds, hail, and thunderstorms.

EDITOR'S TABLE.

MR. SPENCER ON JUSTICE.

THE volume which Mr. Spencer has just put forth under the title of Justice, being the fourth and last part of his proposed first volume on The Principles of Morality, will be eagerly welcomed by a large circle of readers. It has seldom fallen to the lot of a philosopher to awaken so wide an interest and sympathy as Mr. Spencer has done. We can not speak of him as a "popular" writer, yet he writes for the people, and each successive volume that he publishes finds a wider constituency than its predecessor. His style is not adapted for literary epicures; it is not laden with exquisite flavors, nor rich in tone or color, but it has the higher quality of utter truthfulness. Its aim is not to amuse or to flatter, but to convince, and it ever seeks the most direct road to the candid understanding. In illustration Mr. Spencer is unrivaled; he takes the commonest incidents of life and shows their ethical or philosophical significance in such a way as to stimulate at once the reflective and the observing powers of his readers. If the question were asked, What man has done most to promote the intelligence of mankind in the nineteenth century? we think a very good case might be made out for answering — Herbert Spencer. He is a man to whose philosophy the world at large can grow up, for there is something in it for everybody, dealing as it does with every day realities and appealing to principles that are implicit in the most familiar actions and reactions of our mental and moral life.

When we look into a book of Herbert Spencer's we find ourselves carried out at once into the broad currents of general law; or, to express it otherwise, we find ourselves assisting as spectators at the great drama of life—not the life of a special society or time, but the vast unfolding life of species and tribes from the lowliest forms up to man in his highest development. In dealing with Justice, or the ethics of social life, Mr. Spencer takes us back to the kingdom of the subhuman, and shows us that even there the germ of justice exists, and that the conditions are being prepared for its fuller manifestation. We have only space to glance at a few of the more interesting views which the present volume contains, but these, we think, will suffice to prove that Mr. Spencer has here given us a most substantial and valuable contribution to the discussion of a highly important subject. We venture, indeed, to risk the assertion that this work will set the lines on which all future discussions of the question of justice will more or less be conducted.

The primitive law of justice, according to Mr. Spencer, "implies that each individual ought to receive the benefits and the evils of his own nature and subsequent conduct, neither being prevented from having whatever good his actions normally bring him, nor being allowed to shoulder off on to other persons whatever ill is brought to him by his actions." This law is, however, in the higher animals of a gregarious type, and still more in man, qualified by the self-restraint necessitated by association; that is to say, no individual must push the exercise of his active faculties to such a point as to interfere with the exercise of the similar faculties of his neighbors. The latter principle acquires more and more authority the longer association lasts, and the more highly developed it becomes. Thus the idea of justice comes to consist of two elements —an egoistic one, by virtue of which an individual claims benefits proportioned to his merits and faculties; and an altruistic one, by virtue of which he recognizes the right of others to such benefits as may be due to their merits or may flow from a proper use of their faculties. These two elements Mr. Spencer also calls positive and negative—the former positive, as putting forward positive claims; the latter negative, as implying a restraint upon natural liberty.

Another important distinction which Mr. Spencer makes is between the ethics of the family and the ethics of the state. In the family the young have to be cared for, and, in their case, benefits have to be proportioned, not to merits, but to needs, which, in a certain sense, may be described as lack of merits; in other words, the less a child can do that is beneficial to others the more care and attention it must receive. The state, on the other hand, deals with adults, and its guiding principle therefore should be exclusively—benefits according to merits, evils according to demerits. Only confusion and trouble can arise, according to Mr. Spencer, from applying the ethics of the family to state action. He is willing that individuals should exercise a prudent benevolence if they will, but he sees no reason why the state should ever depart from the strictest rule of justice. In discussing The Constitution of the State and the question of giving women the suffrage, he makes the following significant remarks: "Human beings at large, as at present constituted, are far too much swayed by special emotions temporarily excited and not held in check by the aggregate of other emotions; and women are carried away by the feelings of the moment more than men are. This characteristic is at variance with that judicial-mindedness which should guide the making of laws. . . . At present both men and women are led by their feelings to vitiate the ethics of the state by introducing the ethics of the family. But it is especially in the nature of women, as a concomitant of their maternal functions, to yield benefits not in proportion to deserts, but in proportion to the absence of deserts—to give most where capacity is least. . . . The present tendency of both sexes is to contemplate citizens as having claims in proportion to their needs—their needs being habitually proportionate to their demerits; and this tendency, stronger in women than in men, must, if it operates politically, cause a more general fostering of the worse at the expense of the better." These are weighty words, and we can not but hope they may not be entirely inoperative on the minds of modern legislators.

On the subject of political rights our author does not strike at all a popular key. In the chapter entitled Political Rights — so called, he says that such rights are not, strictly speaking, rights at all. A man's substantial rights are, he says, the right to physical integrity, the right to free motion and locomotion, the right to the use of natural media, the right of property, the right of incorporeal property, the right of gift and bequest, the right of free exchange and free contract, the right of free industry, the right of free belief and worship, and the right of free speech and publication. As to political rights, they are merely the supposed means of obtaining the above real rights; and serious mischiefs have resulted from confusing them with real rights. It has been assumed that where political rights were possessed by all, the liberty of all would be secure; but, far from this being the case, we can not fail to observe that, "where so-called political rights are possessed by all, rights properly so called are often unscrupulously trampled upon." For example, "universal suffrage does not prevent the corruptions of municipal governments, which impose heavy local taxes and do very inefficient work, . . . does not prevent citizens from being coerced in their private lives by dictating what they shall not drink; does not prevent an enormous majority of consumers from being heavily taxed by a protective tariff for the benefit of a small minority of manufacturers and artisans." So-called political rights *may* be used for the maintenance of liberties; but "they may fail to be so used, and may even be used for the maintenance of tyrannies."

In his discussion of the Nature of the State we see an illustration of the vast superiority of Mr. Spencer's method over that employed by writers of a simply historical or literary school. Sir Frederick Pollock, in his Introduction to the Science of Politics, says that, to arrive at a true idea of the nature and functions of the state, he can give no better advice than "Back to Aristotle!" Mr. Spencer, on the other hand, shows clearly why Aristotle, advanced thinker as he was for the age in which he lived, can not serve us here, the state, in its essential constitution, being no longer what it was in his day. Very instructive indeed is the contrast which our author draws between the state in a period of perpetual warfare and the state in an era of peaceful industry. In the former case it is obliged to tyrannize over its own citizens; in the latter, it has nothing to do but to see that they do not unduly interfere with one another. Justice in all matters, civil as well as criminal, ought, in the present day, the author holds, to be a right of the individual citizen, to be enforced without cost on application to the proper tribunal. In answer to the objection that, if justice in civil cases could be had without cost, there would be a perfect blockade in the courts, Mr. Spencer declares that, if justice were thus obtainable, the number of offenses would be enormously reduced, which doubtless is true. There are some very interesting chapters in the book on The Limits of State-Duties, which we can not too strongly recommend to the attention of our readers. Mr. Spencer effectually disposes of the notion, so common in our days, that majorities can do no wrong, and that men can not be slaves under a republic. There is a strong temptation to reproduce some of his vigorous and manly utterances on this topic, but we must refrain. It is a great satisfaction to find that Mr. Spencer is again at work, and that there is a prospect that his vast philosophical undertaking will be advanced yet further toward completion, or may even be fully accomplished before he lays down the pen. The volume before us shows a mind as vigorous and as fertile as ever, and the same high, unflinching purpose to effect a great and enduring work of intellectual emancipation and moral regeneration for mankind.

DUTY AS A SCIENCE.

Among the most noteworthy of the summer schools of 1891 was the School of Applied Ethics at Plymouth, Mass. Its formation was due to some of the most successful teachers in America, who had become convinced that, were right conduct cultivated as a science, it would be better practiced as an art; that with due adaptation it should form a part of all education—with, indeed, the aim that schools in every department should be pervaded and vitalized by an ethical atmosphere. From this school's foundation we feel sure will date a new impulse freighted with good to individual character and national life. Since conduct has been so much under the sway of religion, it was fitting that the great faiths of the world should receive extended study. With all the resources of modern scholarship Prof. Toy, of Harvard, set forth the rise and progress of religious ideas, the transformation from faith in many gods to belief in one, the slow crystallization of oral traditions into scriptural canons, the emergence of ethical codes from associations of mythology and ritual. Of his masterly lectures the best lesson lay in their calm scientific spirit. While crediting religions with having given authority to high ideals, he pointed out the inevitable injury which had come from imagining these ideals to be incapable of either lift or expansion. Other lecturers, who have devoted themselves to the study of special faiths, supplemented the discourses of Prof. Toy.

In economics, with incidental excursions into the political sphere, the chief expositions were by Prof. H. C. Adams, of Michigan University. He graphically sketched the history of recent industrial development, and showed how new exigencies had arisen for which adaptations of law and organization were necessary. An era when the massing of machinery is necessary to production, and when monopolies raise their heads on every side, is not to be justly ruled by institutions dating from a time when manufacture was armed with simple tools, and in which over a race of small producers free competition reigned. He viewed with sympathy the growth of trades-unions, regarding them as the chief agency for securing rightful wages. For monopolies he considered the fit check to be the commission, State or Federal, such as now supervises railroads. Publicity of transactions would educate public opinion to demanding public rights. His elucidation of the functions of a commission, and his declaration of faith in its principles, were candidly accompanied by the opinion that so far the Interstate Commerce Commission had not justified its existence. Its four years of life had been too short for legal definition of its powers; it lacked authority to give its opinions effect. President Andrews, of Brown University, in a series of three lectures. set forth "the social plaint," socialism's remedy, and "the better way." His account of the evils under which the masses suffer included everything that intelligent discontent can say. To his rapid survey of socialistic doctrine no socialist could demur. In his view the woes of society will be cured not in one way but many, and along paths in which important steps have been already taken; for example, in profit-sharing and other modes of co-operation. He would reform taxation by making the chief levies on land values, and on the great franchises whose profit is of public creation. In the development of statistical inquiry he saw prospect of relief from industrial crises through an organized adjustment of supply to an ascertained demand. He looked with hope on the beginning which has been made in teaching people how to buy food and cook it, and how to expend their earnings to most advantage. The lessons in practical thrift now introduced in a few schools he deemed worthy of general adoption. In this department of economics men of authority described co-operation, factory legislation, the relief of crowded cities, and modern agrarian movements, including the Farmers' Alliance.

In ethics proper the principal lecturer was Prof. Felix Adler, who, drawing upon his experience with ethical classes in New York, delineated how right conduct may be taught. On the threshold of his subject he confronted the question as to how morals can be taught apart from religion. He averred that a most important body of moral doctrine exists as the common heritage, not only of all religious, but of all men of sound mind and heart. On this he would proceed, teaching authoritatively and ignoring the consideration of sanctions, whether religious or philosophical, which indeed young minds can not weigh. He then outlined the motives of good conduct, the ethicization of the feelings, the duties of self-control, self-improvement, veracity, justice, and charity. Following this came treatment of the ethics of the family, of professional and business life, of citizenship. He indicated the aid which stories afford in teaching young classes; which biography, proverbial and scriptural literature, and history contribute in advanced classes. Throughout the course the interplay between intelligence and conscience was made very clear; plainly did it appear that without knowledge, and much knowledge, without a judgment trained to nice discrimination, the desire to do right and justice in these days of complex social life must be vain. In this department summaries of experience in reform were added by men who have devoted their lives to seeing the Indian righted, the wretched in cities relieved, the prisoner born to new hope and purpose.

LITERARY NOTICES.

Justice: Being Part IV of the Principles of Ethics. By Herbert Spencer. New York: D. Appleton & Co. 1891. Pp. 291.

The appearance of a new volume of the Synthetic Philosophy after a long enforced interval of rest on the part of its author is an event which merits the hearty congratulation, not only of the avowed disciples of Mr. Spencer in America—a goodly and growing number of our most intelligent thinkers—but also of all friends of scientific and liberal thought.

It is now twelve years since the publication of the Data of Ethics. As was then announced, this volume was issued in advance of the regular order of publication, under the pressure of premonitions of failing health. Similar considerations have impelled Mr. Spencer to leave unfinished the concluding sections of The Principles of Sociology and intervening parts of The Principles of Morality, in order to apply himself to the exposition of the law of Justice, which we have his explicit warrant for regarding as the consummate fruit of his patient study and discriminating thought. The noble volumes which have preceded it are all subsidiary to the practical application of the principles of Justice to the pressing problems of our societary life.

Viewed from the standpoint of the philosophical evolutionist, nothing surely could be more timely than the appearance of this work. The past decade has been an era of crude and rash speculation upon social and political problems. In America, no less than in England, we have need to listen to the voice of one who looks neither to the inventions of a closet-philosophy nor to the chance-suggestions of the political empiricist, but to the eternal laws of Nature for wise counsel and enlightenment upon these vast issues. We have recently listened to enthusiasts who expect to abolish poverty and reform society by the simple panacea of the single tax; we have seen a political party spring into an ephemeral existence based upon the success of a visionary novel—the effort of a professional story-writer to imagine a society constructed on principles as foreign as possible to those illustrated in the existing social order. Another political organization promises to abolish crime and regenerate human nature by the simple expedient of prohibiting the manufacture and sale of alcoholic drinks; and anarchistic agitators would abolish the evils of society by the short and easy method of abolishing society itself. It is refreshing to turn from this array of absurdly inadequate panaceas to the wise and conservative counsels of Mr. Spencer, whose more than seventy years, with whatsoever burdens of physical infirmity they may have afflicted him, have detracted nothing from his logical acumen, his clarity of thought, or lucidity of diction.

The first six chapters of the present volume were published in The Nineteenth Century and The Popular Science Monthly in the spring of last year, and their tenor will readily be recalled by the readers of these periodicals. Defining the highest conduct as "that which conduces to the greatest length, breadth, and completeness of life," Mr. Spencer shows that we must seek for the germs of morality in the animal world. He goes further, and shows that human morality is based upon laws which are as universal as life itself, and are active and potent in the development of all living things. The reference to these underlying biological principles runs all through the present volume, and differentiates the treatment of its topics from that of his earlier work, Social Statics, which aimed to cover much of the same ground. Social Statics, however, was not the product of Mr. Spencer's mature thought. He has long been conscious of its imperfections. In the successive volumes of his Synthetic Philosophy he has substituted an exclusively natural or evolutionary treatment for the partially supernatural explanations implied in Social Statics, has made a freer use of the inductive method in support of his deduced principles of ethical and social growth, and has given the law of relativity greater prominence as influencing his practical conclusions, some of which, as expressed tentatively in Social Statics, have been modified or rejected in the present volume.

Defining the objective law of subhuman justice as that social condition wherein "each individual shall receive the benefits and evils of its own nature and its consequent conduct," Mr. Spencer also points out that among gregarious creatures this objective law is modified by the necessity for self-subordination and occasional self-sacrifice in the interest of the species. Human justice is simply a natural development of subhuman justice. The growing necessity for coöperation imposes an increasing obligation for individual restraint; and the social sentiments, of which the sentiment of justice is chief in importance, are correspondingly evolved.

An important difference is pointed out between family ethics and the ethics of the state. In the former the obligations of parents are conditioned upon the children's needs, while in the latter obligations are proportioned to the nature and actions rather than the needs of the individual. A clear distinction is drawn between the *sentiment* of justice and the *idea* of justice. The former may be strong, while the latter is relatively weak. Men may understand clearly that they ought to deal justly by their neighbors, but have a very imperfect comprehension of the course of action which justice requires. The primary characteristic of the idea of justice, contrary to the popular understanding, is that of *inequality*. The natures and consequent activities of individuals are greatly unequal. Justice, therefore, requires that they shall receive correspondingly unequal rewards. The spheres or opportunities of all, however, should be mutually bounded, and hence approximately equal. The formula of justice may accordingly be expressed by saying, "Every man is free to do that which he wills, provided he infringes not the equal freedom of any other man."

Mr. Spencer incidentally defends with great ability the approximate validity of fixed intuitions or deductions against the positivistic disciples of an exclusively inductive method of reasoning. Such intuitions, he shows, "must have been established by that intercourse with things, which, through an enormous past, has, directly or indirectly, determined the organization of the nervous system and certain resulting necessities of thought." Ethical intuitions, however, require the correction of methodic criticism and the application of inductive tests. Both methods work together for the discovery of truth.

In the subsequent chapters the rights and duties of individuals and governments are deduced from the foregoing principles. Man's fundamental right is declared to be that of physical integrity. Under the law of relative ethics this right can only be perfectly maintained in a state of permanent peace. The rights of man to free motion and locomotion are next asserted—rights which conflict, of course, with all forms of serfdom or slavery. The recognition of these rights is said to have been of very recent origin. In early times "the conception of freedom as an inalienable right had little or no place either in ethics or law. . . . Neither Christ nor his apostles denounced slavery." It may, however, be maintained by Christian apologists that certain seed-principles contained in the Gospels are in logical conflict with slavery, and exerted a powerful though indirect influence toward its overthrow.

In the important chapter on The Right to the Uses of Natural Media, after noticing some of the habitual infringements on the admitted right of all to free light and air—as by smokers in public places, injurious fumes from chemical works, bad street music, etc.—Mr. Spencer attacks the much-agitated land question. He reaffirms the principle laid down in Social Statics, that all men have a natural right to the use of the soil—a right which, he strongly asserts, has everywhere been alienated by force and fraud. Its fundamental character is now tacitly admitted, however, he claims, in the universally recognized principle of eminent domain, in defense of which he quotes Sir Frederick Pollock. His final conclusions on this subject, however, will not be acceptable to the followers of Henry George. After calling attention to the great difference between the value of the land in its primitive state and its present value, and to many practical difficulties in the way of the resumption of state-ownership, Mr. Spencer says:

. . . "The landless have not an equitable claim to the land in its present state—cleared, drained, fenced, fertilized, and furnished with farm buildings, etc.—but only to the land in its primitive state; . . . this only it is which belongs to the community."

Referring to his argument for communal ownership in Social Statics, he declares, "A fuller consideration of the matter has led me to the conclusion that individual ownership, subject to state-suzerainty, should be maintained.

"Even were it possible . . . to make a rearrangement equitable in the abstract, the resulting state of things would be a less desirable one than the present. . . . It suffices to remember the inferiority of public administration to private administration, to see that ownership by the state would work ill. Under the existing system of ownership those who manage the land experience a direct connection between effort and benefit, while, were it under state-ownership, those who managed it would experience no such direct connection. The vices of officialism would inevitably entail immense evils."

In affirming the right of the individual to property in general as against the communistic idea, Mr. Spencer is particularly clear and cogent, showing that the fundamental law of justice can only thus be fulfilled.

The right of incorporeal property, as in copyrights and inventions, is clearly and logically asserted. The right to sue and obtain damages for unjust assaults on personal reputation is also defended. Mr. Spencer maintains, however, in opposition to prevalent legal custom, that there is no ethical warrant for the punishment of a person who injures the reputation of another by stating unpalatable truths in regard to him. The exposure of a false reputation, he says, may often prove a public benefit. The rights of gift and bequest follow as legitimate deductions from the foregoing principles applying to property and land.

The advocates of a "protective" tariff will hardly derive much comfort from Mr. Spencer's discussion of The Rights of Free Exchange and Free Contract. The only legitimate qualification of these rights which Mr. Spencer admits is "where there is good evidence that freedom of exchange would endanger national defense." "Those who have been allowed to call themselves 'protectionists' should be called aggressionists; since forbidding A to buy of B, and forcing him to buy of C (usually on worse terms), is clearly a trespass on that right of free exchange which we have seen to be a corollary from the law of equal freedom."

Mr. Spencer asserts the rights to free belief and free worship in a clear though brief statement, deeming any lengthy argument in their support unnecessary. The rights of free speech and publication are likewise lucidly and forcefully maintained; free speech being "still the agency by which error is to be dissipated." On the delicate question of the discussion of the matters of sexual morality, Mr. Spencer argues from historical data that it is not reasonable to take for granted that our own customs are above criticism, and holds that the evils incident upon a free discussion of such topics "must be tolerated in consideration of the possible benefits." Public opinion, he thinks, may be trusted to hold these evils in check.

In a retrospective chapter, Mr. Spencer adduces several lines of deductive and inductive verification of these principles, holding that the convergence of all these lines of inquiry justifies us in regarding the law of equal freedom as of supreme ethical value, leading us to conclusions involving "as great a certainty as can be imagined."

The important chapter on the Rights of Women gives evidence of the careful consideration of a difficult problem by a just, conservative, and well-balanced mind. Mr. Spencer holds that women, as the weaker sex, should not be artificially disadvantaged in the struggle for life. He asserts that "no restraints can equitably be placed upon women in respect to the occupations, professions, or other careers which they may wish to adopt." In the final adjustment of property rights he thinks that "the discharge of domestic and maternal duties by the wife may ordinarily be held a fair equivalent for the earning of an income by the husband."

As to political rights or privileges, he holds that those of women are not to be regarded as identical with those of men. With men, the possession of the suffrage involves the obligation to become military defenders of the nation. Women have not the same liabilities; hence, if they are granted identical privileges, their position is not one of equality but of superiority to men. The question of equal political rights for women can not be entertained, he argues, until we reach a state of permanent peace. In criticism of this view, it may be maintained, we think, in accordance with a logic which Mr. Spencer has himself recognized in treating of the property rights of women, that the question is not so much one of identity of function and obligation as of just equivalence. Even in case of war, it may not unjustly be held that the services of women, in the hospital and in the home, as tax-payers and wage-earners, as mothers and educators of the country's defenders, constitute a fair equivalent to the services of men in the field, and entitle women to equal political consideration, all other conditions being identical. Moreover, large classes of men are legally exempt from military service, by age, occupation, or physical disqualification, but such persons are not therefore disfranchised. Evidently, therefore, suffrage is not conditioned, *de facto*, upon military service or ability therefor. Nor, happily, are the problems of government mainly those growing out of physical conflicts between nations. The arguments against enfranchising women in the later chapter on The Constitution of the State, based on their constitutional differences from men—their comparative impulsiveness, emotional susceptibility, and relative inability to recognize the force of abstract and remote considerations, bearing upon the public welfare—appear to us to have much greater weight than the by no means novel argument based on the incapacity of women for military service. They will doubtless seem to many minds at present conclusive. Mr. Spencer, it should be said, expressly disclaims the application of this argument as an objection to local or municipal suffrage for women.

In discussing the rights of children, the reciprocal duties of parent and child are clearly outlined, and the necessity of giving the child a gradually increasing freedom of action to fit him for the independent or self-directed activities of his adult life is strongly affirmed.

With a notable series of chapters on the nature, constitution and duties of the State, Mr. Spencer concludes the present volume. In many respects these chapters constitute the most suggestive and valuable part of this discussion. Nowhere else have the nature and duties of citizenship, and the proper limitations of state-control over the individual, been so clearly and tersely set forth. With admirable brevity and lucidity, Mr. Spencer first shows the fallacy of the eighteenth-century doctrine of political rights, a doctrine which still finds intelligent supporters, especially in democratic and republican communities like our own. The only rights, truly so called, which man possesses, he affirms, are the personal rights to life, freedom, security, etc. Political privileges are instrumental, in greater or less measure, depending on the state of culture and civilization, in maintaining these rights; and they can only be claimed in virtue of their efficiency in securing this end. "The giving of a vote," e. g, "considered in itself, in no way furthers the voter's life, as does the exercise of those various liberties we properly call rights. All we can say is that the possession of the franchise by each citizen gives the citizens in general the power of checking trespasses upon their rights; powers which they may or may not use to good purpose" (page 177).

Attention is called to the fact that in France the bureaucratic despotism is as great under the republic as it was under the empire; and that in America universal suffrage does not prevent corruptions of municipal government, the surrender of power to wire-pullers and bosses, the coercion of the citizens by laws dictating what they shall not drink, and the taxation of the many for the benefit of the few by a "protective" tariff. "The so-called political rights may be used for the maintenance of liberties, they may fail to be so used, and may even be used for the establishment of tyrannies."

In considering The Nature of the State,

it is pointed out that "the end to be achieved by the society in its corporate capacity, that is, by the state, is the welfare of its units; for the society having as an aggregate no sentiency, its preservation is a desideratum only as subserving individual sentiencies." This is a most important principle, which should always modify the modern evolutionary conception of society as an organism, and prevent that subordination of the individual which must result from the application of socialistic principles to governmental affairs. The modern state, Mr. Spencer shows, is in process of evolution from the militant type, in which successful aggressive activities demand and develop the principle of centralization, toward the industrial type, based upon contract. In its final development the constitution of the state "appropriate to that industrial type of society in which equity is fully realized, must be one in which there is not a representation of individuals but a representation of interests. For the health of the social organism and the welfare of its members, a balance of functions is requisite; and this balance can not be maintained by giving to each function a power proportionate to the number of functionaries." This principle, which constitutes, perhaps, the most suggestive and original part of Mr. Spencer's discussion of governmental methods, will doubtless meet with much opposition and criticism in our own and similarly constituted communities. It is evidently, however, the product of a most careful study of existing societies, and a judicial consideration of their obvious merits and defects. It is worthy of the thoughtful attention of all students of society and government.

In discussing the duties of the state, Mr. Spencer argues that as societies advance from the militant toward the industrial type, state functions will be less and less adapted to repelling external aggressors and more and more to the maintenance of the conditions of justice against the assaults of internal enemies—the ignorant, vicious, and depraved, who constitute abnormal elements in all large societies. For the better fulfillment of this obligation, he believes it to be the duty of the state to administer justice without cost—to arbitrate between citizens gratuitously. His arguments in this behalf, and replies to anticipated objections, are forceful and worthy of the serious attention of our statesmen and philosophers. A further duty of the state is to act as trustee for the supervision of the inhabited territory, with reference to the building of roadways, canals, and railroads; the establishment and repair of water, gas, telegraph, and kindred appliances, etc. The actual introduction and maintenance of public works should, however, usually be left to private enterprise. The paternal theory of government contradicts the fundamental principles of justice by introducing into the state the contrary ethics of the family. "The only justification for the analogy between parent and child and government and people," he says, "is the childishness of the people who entertain the analogy" (page 217).

No candid and thoughtful man, unbiased by socialistic preconceptions, can read the concluding chapters of this book without being convinced that the true progress of governmental institutions must lie along the lines which Mr. Spencer has indicated. The philosophical evolutionist can but agree with him that "all-embracing state-functions characterize a low social type; and progress to a higher social type is marked by a relinquishment of functions" (page 230). The vices and inefficiencies of the civil service, so lucidly described in these chapters, are defects of our American institutions no less than of those of the mother-country. Wherever they exist they are largely due to the failure to comprehend and apply the fundamental principles of equity and justice, so well defined by Mr. Spencer. So far as these false methods are defensible at all, they are habitually defended by arguments avowedly based on considerations of custom and immediate utility. It should be evident, however, none the less to us than to Mr. Spencer, that "this empirical utilitarianism, which makes happiness the immediate end, stands in contrast with the rational utilitarianism, which aims at the fulfillment of the conditions of happiness." The excellence and sufficiency of Mr. Spencer's ethical theory nowhere appeal so conclusively to the enlightened understanding as under the crucial test of its practical applications. The thoughtful moralist who is thoroughly acquainted with the facts of our existing societary conditions can hardly avoid the conclusion thus tersely expressed in the final chapter of this work:

"The end which the statesman should keep in view as higher than all other ends is the formation of character. And if there is entertained a right conception of the character which should be formed, and of the means by which it may be formed, the exclusion of multiplied state agencies is necessarily implied."

As we ponder upon the wise counsels of this noble exposition and defense of the principles of justice, we may well congratulate ourselves, as Americans, that we were early to discover the genius and ability of him whom Mr. Darwin well named "our great philosopher." We may likewise congratulate Mr. Spencer on the renewal of health which has enabled him to make this most important contribution to the literature of ethics and philosophy. May we not hail it as a harbinger of hope that his strength will be husbanded and his life prolonged for the complete accomplishment of that self-imposed task which, even in its present unfinished state, constitutes unquestionably the greatest literary achievement of the present century?

Studies of the Gods in Greece at Certain Sanctuaries recently excavated. By Louis Dyer. London and New York: Macmillan & Co. Pp. 457. Price, $2.50.

These studies were originally given in eight lectures delivered in 1890 at the Lowell Institute. They were repeated before various universities, colleges, and societies in the United States, and are now published with corrections and notes, the fruit of a year's deliberation. The author seems to be inspired by an enthusiasm for the Greek religion similar to that which Schliemann had for its Homeric associations. To him it was the beautiful and ennobling religion, first of Greece, and then—through Greece and Rome—of all the ancient world; and the sanctuaries where it had its growth were places "where that old-time worship of ideals, by some miscalled idolatry, grew pure and yet more pure, broad and broader still, until its inner significance and truth were no longer to be confined within old forms, could be fettered no longer by old ·ds; and lo! Christianity was there to gather in a heritage of high-born thoughts from Greece." To the religion of Greece and Rome, the author says in another place, "to the Eleusinian mysteries, to the worship of Æsculapius and Apollo, to the adoration of Aphrodite, is due more of the fullness and comforting power of the Church to-day than many of her leaders have been willing to allow." In the spirit revealed by these words, of judging Greek religion not by all its moods, but by all its highest and most characteristic ones, are discussed the worship of Demeter and Persephone, and of Dionysus at Eleusis, of Æsculapius at Athens and Epidaurus, of Aphrodite at Old Paphos, and of Apollo at Delos, on all of which light has been cast by recent excavations at their particular shrines. Various corollaries of the main subject are considered in appendixes; and plans are given of three of the temples.

Electricity: The Science of the Nineteenth Century. By E. M. Caillard. New York: D. Appleton & Co. Pp. 310. Price, $1.25.

This volume appeals to the large class of educated readers without scientific training who may wish for some comprehension of electrical principles. No mathematical computations or technical processes are given, but the resultant laws are clearly stated, illustrated by interesting experiments and explanations of recent inventions. The author has made four divisions of her work: Static Electricity; Magnetism; Current Electricity; and Appliances of Electricity. Under the first head a brief outline of electrical development and elementary facts is followed by a description of frictional machines and the "electrophorus." A "charge" is produced because "all bodies are not equally good conductors," and the storing of electricity is compared to the accumulation of water, the insulator acting similarly to a dam. As the existence of air is shown by the wind-storm, so the presence of electricity is exhibited in discharge. "Potential" is defined as the comparative electrical condition of a body. If the same amount of electricity be conveyed to two different bodies, the smaller one may be at high potential and the larger at low potential, "potential" bearing the same relation to electricity that level bears to water. The Leyden jar is an example of two conductors separated by an insulating medium and may be used to exhibit some of the recent discoveries as well as simpler phenomena. An analogy is found for the charged Leyden jar in the atmospheric condition preceding a thunderstorm when the air between the earth and clouds is under the same strain as the glass.

The theory of molecular magnetization accounts best for the properties of magnets and the study of terrestrial magnetism confirms the coincidence of magnetic storms and sun-spots. All electrical manifestation results in discharge, but current electricity consists in a *continuous* flow. The usual way of producing this by galvanic battery, the chemical, physiological, and magnetic effects are next examined. The practical units of measurement, the *volt*, *ohm*, *ampère*, and *coulomb*, are usually employed with prefixes signifying a million-fold or millionth, thousand-fold or thosuandth. In the last section various magneto-electric, dynamo machines, and electric motors are described and illustrated; also, electric lighting, railways, telpherage, the telephone, and many minor electrical devices; and the application of electricity to metallurgy in electro-plating, electrotyping and welding. The nature of electricity is discussed. Since the detection of electro-magnetic waves that can be reflected, refracted, and polarized like those of light, the "electro-magnetic theory of light" has been accepted and "we may say that electrical science includes the whole of optics, or that optics includes the whole of electrical science, whichever way we like to put it."

The Criminal Jurisprudence of the Ancient Hebrews. Compiled from the Talmud and other Rabbinical Writings, and compared with Roman and English Criminal Jurisprudence. By S. Mendelsohn. Baltimore: M. Curlander. Pp. 270. Price, $2.50.

The author of this book is Rabbi of the Jewish congregation "Temple of Israel," at Wilmington, N. C. He is described as a man of great learning, and the accuracy of his work is testified to by prominent Hebrew clergymen on the side of Talmudic data, and by "lawyers of renown" on that of the civil and common law. His purpose in preparing it has been to acquaint the world with the system of criminal jurisprudence unfolded in the Talmud, and to contribute to the vindication of the Israelitish people's ancient literature from aspersions which have been cast upon it. His language on the latter point leads us to infer that he hardly realizes the attention Talmudic literature has received in later days from students, and underrates the respect in which it is held by theologians and scholars. In the course of his essay he unfolds the thesis that the system of criminal jurisprudence of the ancient Hebrews, as recorded in the Talmud and contemporaneous rabbinic literature, was one which enforced civil order and secured the safety and peace of society by mildness and consideration; and this in an age of savagery and violence, of wars and uncertainty. While in England, one hundred years ago, one hundred and sixty offenses were punishable with death, that penalty was inflicted among the Hebrews for only thirty-six offenses. The *lex talionis*, an eye for an eye, etc., prescribed by Moses, and not unknown to the old English law, gave way, under the rabbis, to a pecuniary compensation; and it was the custom of the rabbis, sitting in judgment over a human being, to lay every possible legitimate obstacle in the way of conviction. In the body of the work a syllabus is furnished of the principal penal statutes established by the ancient Jews and preserved in the Talmud and contemporaneous rabbinical books, under the headings of Crimes and Punishments, The Synhedrion, The Trial, and The Execution. An account of the Talmud, historical and analytical, is given in an appendix.

An Introduction to the Study of Botany. By Edward Aveling. New York: Macmillan & Co. Pp. 363. Price, $1.10.

This volume is intended as a guide to the practical study of the subject, and assumes no knowledge of it on the part of the reader. The syllabus of the Science and Art Department at South Kensington is taken as a basis for the general plan of the work, but it is intended to help all who enter upon the study, no matter what particular end they may have in view. The lessons are expected to be taken from the plant, and the book to be subsidiary to the practical study. Following the method of working from the known to the unknown, it begins with the examination and description of familiar plants; and, in learning to dissect and describe those objects, the student will also be mastering the general and the special morphology, histology, and physiology of the plant. The first chapter gives the general definitions of botany and its divisions. In the second chapter the buttercup is taken up for dissection and description, and its characteristics and relationships are brought out as typical of the *Ranunculaceæ*. In a similar way the succeeding chapters deal with typical examples of other orders; after which the student is introduced to "The Vegetable Cell," "Cell Contents," "Tissues and Systems," "The Root," "The Stem," "The Leaf," "Inflorescence, Floral Organs, and Fruits," and "Classification."

Taxidermy and Zoölogical Collecting. By William T. Hornaday. New York: Charles Scribner's Sons. Pp. 362. Price, $2.50.

Mr. Hornaday aims, in this volume, to present a complete hand-book for the amateur taxidermist, collector, osteologist, museum-builder, sportsman, and traveler. The author speaks of it as "an affair of the heart," and hopes that "it may be the means of materially increasing the world's store of well-selected and well-preserved examples of the beautiful and interesting animal forms that now inhabit the earth and its waters." He thinks that previous works on the subject are not practical enough, saying, "The average book on taxidermy contains four times too much 'padding,' and not one quarter enough practical information," and would remedy the defect. As a reason for publishing such a book now, he urges: "The rapid and alarming destruction of all forms of wild animal life which is now going on furiously throughout the entire world renders it imperatively necessary for those who would build up great geological collections to be up and doing before any more of the leading species are exterminated"; and "*Now* is the time to collect. A little later it will cost a great deal more, and the collector will get a great deal less; . . . and it is my firm belief that the time will come when the majority of the vertebrate species now inhabiting the earth in a wild state will be either totally exterminated or exist only under protection. But do not launch out as a collector until you know how to collect. The observance of this principle would have saved the useless slaughter of tens of thousands of living creatures, and prevented the accumulation of tons upon tons of useless rubbish in the zoölogical museums of the world." The caution in these passages is more important than the incitement. There are too many collectors abroad and they are too indiscriminate. It would be well to reduce the number and select from them, and then give the selected ones such a book as Mr. Hornaday's. Some species are in as much danger from collectors as from any other source; and all species, when collected, should be put to the best possible use for instruction. Mr. Hornaday's book excellently fulfills its purpose, and avoids the faults he finds with its predecessors. It gives full information, in six parts, on collecting and preserving mammals, birds, reptiles, fishes, marine invertebrates, and birds' eggs and nests; taxidermy, mounting, and group-making; making casts; osteology, or preparing and mounting skeletons; the collection and preservation of insects; and general information respecting insect pests and poisoning, books of reference, etc. It is handsomely and liberally illustrated by Charles Bradford Hudson and other artists. The chapter on Collecting and preserving Insects is by Dr. J. W. Holland, and the author acknowledges obligations for assistance to other experts.

A Primer of Ethics. Edited by Benjamin B. Comegys. Boston: Ginn & Co. Pp. 127.

There can be no question that Mr. Comegys has prepared a timely text-book. Character training is equally if not more important than mental or manual training, but receives scant attention. Carelessly considered as inseparable from religious instruction, it has been left to the Church, and the Church now concerns itself with creeds rather than conduct. An old maxim holds good in this instance, for between church, home, and state, the most needed education is treated in hap-hazard fashion and falls to the ground, while multitudes grow up to manhood and womanhood without other moral instruction than what they may have inhaled with the air, and possessing such notions of rectitude that they might be put to the blush by a barbarian.

The handy little volume that suggests right and wrong as worthy subjects for study is founded upon the Rollo Code of Morals, by Jacob Abbott. This has been abridged and altered to suit present needs. The contents include a score of lessons upon fundamental duties. A principle is stated in concise form at the beginning of each lesson; stories illustrating it, or any deviation from it, follow; and, in conclusion, questions are given, not only upon the subject-matter furnished, but upon other cases not mentioned in the text, thus stimulating the pupil to think for himself. The arrangement is admirable, the language simple and direct, and the stories such as to interest children. Now that the book is written giving primary ethical truths without religious doctrine, it is to be hoped that it will be put into immediate use. It may possibly be objected by school committees that, although containing no more theology than simple theism, it has a pronounced political bias. It undoubtedly tends to discourage party rings and truckling to power, and may thus be construed to openly aid and abet civil-service reform. Yet, as no code of morality can be drawn up of sufficient latitude for political use, it can be explained to the pupil that electioneering and lobbying form exceptions to ethical rules.

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POPULAR MISCELLANY.

The American Microscopical Society.—The American Microscopical Society was the first of the scientific organizations to meet this year at Washington. Dr. John S. Billings made an address of welcome, and spoke at some length of the microscopic work that was done at Washington in the scientific offices of the Government, by the local society, in the Army Medical Museum, and particularly of that of the late Dr. J. J. Woodward. The use of the microscope in Government work was further discussed by Dr. J. Melvin Lamb. Most of the papers read were technical, but one by President Frank L. James, on the Microscope in the Investigation of Scorches and Burns on Textile Fabrics, relating how the instrument had been applied to establish the innocence of a man charged with murder, was of general interest. A committee was appointed to consider the feasibility of inducing American manufacturers to make their instruments of the same standard. A proposed new constitution was considered, and the society decided that it would call itself in future the American Microscopical Society instead of the American Society of Microscopists.

Value of Economic Entomology.—The study of insects was exalted in the address of Mr. James Fletcher as President of the Association of Economic Entomologists, who asserted that there is no branch of natural science or practical agriculture to which entomology is second in importance. The amounts lost and the value of the produce which might be saved every year in our staple crops alone by following the advice of the competent entomologist are so enormous, and of late years have been so often proved, that before long the value of these studies must certainly be more generally recognized. The chief hindrance is ignorance on the part of growers and consumers of agricultural products, which is being rapidly dissipated by the work of the agricultural experiment stations. Estimating the value of the agricultural crops of the country at about $380,000,000, an average of about ten per cent, or $38,000,000, was now lost—given up to insects without a struggle.

The Farmers' Crisis.—Nothing will be gained for us, either from an economic or political point of view, said Prof. E. J. James in his address before the Economic Section of the American Association, by belittling or deriding the views of Western farmers on the money question, on the tariff, or on railroad policy, taxation, and other topics. The American farmer has a grievance—a real and true grievance—one that will not become less by pooh-poohing it, but one that must be carefully studied by students of economics and statistics to ascertain, if possible, how far it is justified and whether it can be remedied, and, if so, by what means. As a matter of fact, the wealth of the United States is flowing away from its farms into its factories and railroads; from the country into the city; from the rural into the urban districts. The policy of our railroad companies has borne hard upon the individual farmer and upon the farmers as a class. It has altered all the conditions of agriculture in many sections of the country, and in nearly all of them in such a way as needlessly to burden and embarrass the farmer. Our system of taxation rests most heavily upon him; and there is no doubt that the financial policy of the country, including the whole system of monetary transactions built up by the combination of governmental and private initiatives, discriminates directly and keenly against the farmer and farming class, by discriminating in favor of other classes. Nor can it be said that the tariff policy of the country has been managed as much to the farmer's interest as to that of other classes. The way to improvement lies, in the first place, in the direction of altering these adverse influences. This policy, however, is merely palliative, and does not go to the root of the matter. The forces which are crowding the American farmer to the wall are world-wide. He is at a disadvantage because he is trying to compete with farmers of a low grade of civilization and intelligence in the production of crops in which intelligence and civilization count for comparatively little; and this competition is destined to become more formidable. The American farmer must seek new crops where intelligence and skill count for more than mere fertility of soil or juxtaposition to market, and where, having once established himself, he may bid defiance to the ignorance and inefficiency of foreign peasant, ryot, or boor. This calls for a broad and liberal policy toward agriculture in all its relations.

The Natural History of Analogy.—The subject of Prof. Jastrow's address in the Anthropological Section of the American Association was The Natural History of Analogy. Although this form of argument is used with great caution to-day, it was a predominant form among primitive people. Abundant instances of it were found in almost all savage customs and beliefs. In magical rites, in interpretations of omens and dreams, in medicinal practices, and social and tribal customs, striking instances of this kind of argument abounded. The Zulu who chews a bit of wood to soften the heart of the man he wants to buy an ox from, the fetich determining by whether a stick stands or falls whether a war shall be kept up or allowed to stop, the medicine-man who performs incantations over some personal belonging of his victim, or by the use of out-of-the-way drugs—were all instanced as the results of a feeling of analogy. Similar traits exist in children. An abundant field of illustration may be found in the popular superstitions, folk lore, and customs that have survived from a lower to a higher culture. The modern dream-book, household medicinal practices, charms, astrology, the doctrine of sympathies, furnish illustrations in point.

Derivation of the American University.—In his address on the Evolution of the University Prof. George E. Howard, of the University of Nebraska, traces the derivation of the American university through Oxford and Cambridge from the *studium generale* of Paris. The English college is regarded as "the direct prototype of the first American schools. The three most important foundations of the colonial period, which eventually became the models, directly or indirectly, of nearly all our higher institutions of learning, were in aim and organization reproductions of Cambridge or Oxford Colleges, with such modifications as new environments, religious ideas, and isolated position rendered necessary. Unfortunately, the principal defects of the English system were perpetuated. Thus the English universities were state institutions placed in subordination to a church establishment. Harvard, Yale, and William and Mary were in character practically the same. Each was chartered by the state—by the Colonial Assembly or the British Government—for religious purposes." Harvard escaped ecclesiastical trammels most easily, because in 1638, the theocracy being at its meridian, it was inconceivable that the clergy should not control the college, and they were not imposed so strictly as on the other institutions. American institutions also inherited from the mother-country a narrow conception of the sphere to be assigned to higher education—that scholastic spirit which has prevented our schools from entering into their proper relation to society. "Hence it is that the college professor, even yet, is too often the last man whom the people think of consulting on practical questions." Higher education is, however, undergoing a revolution which is briefly described as a tendency toward bringing the schools into closer relation with the social organism. This appears in several ways. The student, while devoting himself mainly to the duties of his academic life, remains a member of the social body. In our best institutions the relations of the student to his teacher are becoming such as are favorable to the development of manliness and independence of judgment. While the classics and other branches of the old curriculum have been retained, and, subjected to the comparative method, are made vastly more productive than ever before for culture and general social good, a multitude of new subjects have been introduced. Instruction preparatory to nearly every new industry and profession is provided. Attention is given to questions that concern the state and the community at large. Administration, finance, constitutional history, constitutional law, comparative politics, railroad problems, corporations, forestry, veterinary science, charities, statistics, social problems—a crowd of topics, many of which a few years ago were unheard of in the schools—are now in many places subjected to methodical treatment. It is in the absolute necessity in the present crisis of the nation of providing the means of instruction in these branches that we find a strong argument in favor of the public support of higher education. The subjects mentioned, which enter into matters of daily and general interest, can be successfully treated only by specialists, and they must be trained in the schools.

The Colorado Cañon.—As described by Dr. D. Hart Merriam in one of the publications of the Department of Agriculture: "The Grand Cañon of the Colorado at the point visited is about fifteen miles wide at the top and six thousand feet deep. It is intersected by gulches and side-cañons of gigantic dimensions. It has ledges, terraces, and *mesas*, barren crags and grassy slopes, lofty mountains and deep valleys, cool hillsides clad in forests of balsam firs, and hot bottoms filled with subtropical thickets. It has arid stretches of sand bearing a scattered growth of cactus and yucca, and marshes and springs that never become dry and are hidden by the verdure of a multitude of plants requiring a moisture-laden atmosphere for their existence. Its animal life is as sharply varied and as strongly contrasted. In descending from the plateau level to the bottom of the cañon a succession of temperature zones is encountered equivalent to those stretching from the coniferous forests of northern Canada to the cactus plains of Mexico. These zones result from the combined effect of altitude and slope exposure, the effects of the latter being here manifested in an unusual degree. . . . The complex and interacting effects of radiation and refraction, of aridity and humidity, of marked differences of temperature at places of equal altitude on opposite sides of the cañon, of every possible angle of slope exposure, of exposure to and protection from wind and storms, produce a diversity of climatic conditions the effect of which on the vegetable and animal life in the cañon has been to bring into close proximity species characteristic of widely separated regions, and to crowd the several life zones into narrow parallel bands along the sides of the cañon—bands which expand and contract in conforming to the ever-changing surface."

The Sound of the Aurora.—"As to the aurora making an audible sound," says Mr. William Ogilvie in his The Upper Yukon and the Mackenzie, "although I often listened when there was a very brilliant display, and despite the profound stillness which is favorable to hearing the sound, if any sound occurs, I can not say that I ever even fancied that I heard anything. I have often met people who said they could hear a slight rustling sound whenever the aurora made a sudden rush. One man, a member of my party in 1882, was so positive of this that on the 18th of November, when there was an unusually brilliant and extensive display, I took him beyond all noise of the camp, blindfolded him, and told him to let me know when he heard anything, while I watched the play of the streamers. At nearly every brilliant rush of the auroral light he exclaimed, 'Don't you hear it?' All the time I was unconscious of any sensation of sound."

Agricultural Experiment in Wyoming.—In order that the possibilities of agriculture in all parts and altitudes of Wyoming may be fairly tested, the Trustees of the State Experiment Station have established experiment farms in various portions of the State. The west-central portion and the altitude of 5,500 feet above sea-level is represented by the Lander experiment farm of 137 acres under irrigation in Fremont County;

the Laramie plains and the altitude of 7,000 feet is represented by the Wyoming University experiment farm of 610 acres in Albany County, irrigated from the Pioneer Canal; the North Platte Valley and the altitude of 6,000 feet, by the Saratoga experiment farm of 40 acres, also under irrigation, in Carbon County; the northern part of the State and the altitude of 4,000 feet, by the Sheridan farm of 50 acres, under irrigation, in Sheridan County; northeastern Wyoming, with the greatest rainfall and the altitude of 4,500 feet, by the Sundance farm of 49 acres, to be carried on without irrigation, in Crook County; and southeastern Wyoming, the Sybille Valley, and the altitude of 5,000 feet, by the Wheatland farm, under irrigation, in Laramie County. This distribution gives a good representation of the agricultural and grazing lands of the State; but other experiment farms will be established as the station funds permit. Researches are now in progress as to the capacity of gypsum to absorb and retain moisture. Special experiments have been instituted with varieties of grass and forage plants to be grown without irrigation.

Strychnine and Snake-bite.— The treatment of snake-bite with injections of strychnine illustrates the antagonistic action of poisons upon one another. Dr. Mueller, of Yackandandah, Victoria, in a case in his practice, used a solution of nitrate of strychnine in water with a little glycerin, hypodermically injected, with a frequency which was determined by the symptoms. When all symptoms had disappeared, the first independent action of the strychnine was shown by slight muscular spasms. The injections must be discontinued then, unless the snake-poison reasserts itself. In some cases a grain or more of strychnine was used within a few hours. The two poisons are thoroughly antagonistic, and no hesitation need be felt in pushing the use of the drug to quantities that would be fatal in the absence of snake-poison.

Irrigation in Egypt.—According to a note contributed to Nature by Sir Colin Moncrieff, the problem of perennial irrigation in Egypt has been satisfactorily solved, and that without the aid of the *corvée*, or forced labor. The subject of irrigation is treated under two broad subdivisions—the irrigation effected by the Nile flood, when there is rich, muddy water in abundance for a land three times as large as Egypt, and when every one considers it his absolute right to have his fields flooded without the expense or trouble of raising the water artificially; and the irrigation effected by the Nile at its lowest, in May and June, when it is only by the strictest economy that an area not exceeding one fourth of the whole of Egypt can be irrigated. It has now been made possible to raise the water in the river and divert it into the canals by the completion of a barrage or dam at the apex of the Delta. Such a dam was built several years ago, but soon after it was finished it cracked in an alarming way, and was not used. It cost originally about £2,000,000, and has now been put in a condition to fulfill the purpose for which it was intended, for the sum of about £460,000. This result is contrasted with the estimate of M. Linant, a former Government engineer, in 1872, that it would probably cost more to repair the existing barrage than to build a new one, and proposed pumping instead, at a cost of £465,000 per annum. Drainage for carrying off the superfluous water, which was not provided for in the French plans, is amply effected under the new system.

Bahama Fairy Tales.—The fairy tales of the negroes of the Bahamas, as described by Mr. Charles L. Edwards in a paper on that subject, are strongly localized, and built into a folk lore that is at once peculiar and interesting. The negro children are for the most part the medium of perpetuating them, but the conventional negro dialect is considerably modified by an intermixture of cockney and of correct English pronunciations. The same tale narrated by different persons, and by the same person at different times, will vary in the pronunciation of some of the words, and in unimportant details of the plot. The tales are divided by the narrators into "old stories" and "fairy stories," of which the former include the folk lore proper. The fairy stories have generally suffered modification in their transition into Bahama lore, and in some cases it is very difficult to detect the original. The "old stories" have to do mainly with animals, while the characters in the fairy tales are generally human beings. The "Brer" of Uncle Remus, or the "Buh" of Charles C. Jones, is among the Bahama negroes contracted to B', which, connected with the name of the animal, personifies it. The habit of mixing together the parts of several tales in order to make one, as is seen in some of the fairy stories, gives us an odd and generally more or less obscure resultant tale. Prof. Crane, in his review of Uncle Remus (Popular Science Monthly, vol. xviii, p. 824), gives a number of parallel stories from the folk lore of other races, especially comparing the tales of the Southern negroes with those of the natives of South America, which illustrates the negro origin of the Indian tales, and points out their wide diffusion.

The First Ship that tacked.—The British sixteenth-century war-ship Great Harry, a supposed model of which was shown at the Naval Exhibition at Chelsea, possessed a great historical interest, because she was the first war-ship to sail on the wind. Naval architecture, says Nature, "as a science, was not founded until it was discovered that ships could be, otherwise than by the aid of oars, taken to the quarter from which the wind was blowing. It must have seemed a great feat in those days—little less than necromancy. Fortunately for the timid intellects of our ancestors, the revelation broke upon them gently, for the rounded hulls, high topsides, and curiously rigged craft could not have sailed more than a point or two to windward. Still, it was the Great Harry, or one of her contemporaries, by means of which this new feature in seamanship was inaugurated—a feature by which the middle period in the world's history of naval warfare was created, and which enabled the sailors of those times to make a distinct advance upon the lessons taught them by their ancestors in the art of shipcraft."

The Kibanga Calendar.—According to the Algerian missionary, Father Vyncke, the negroes of Kibanga, on the western shore of the Tanganyika Lake, although the sun passes twice a year perpendicularly over their heads, take no account of its march, and have no idea of the solar year. But the moon plays an important part in their lives. They celebrate its reappearance with drum-beatings, gunshots, and cries of joy. The new moon is celebrated with general dancing by most of the African tribes; and to keep the run of its age they have a bundle of twenty-eight or thirty sticks, from which they take one every day. The stars are consulted for the determination of the seasons, and to know when it is time for work in the fields, fishing, etc. The rising of the Pleiades marks seed-sowing time and is celebrated by feasts in honor of the dead, and the constellation is given a name, *Kiti*, significant of the fact. The milky way is designated by a name signifying the line between the dry and the rainy seasons, because when it rises at sunset the rainy season begins. The rising of Orion's belt determines the beginning of an important fishery. When another star, not named by Father Vyncke, reaches the zenith, the women begin to pound manioc. Aldebaran is the Northern, and Sirius the Southern Jewel. The Centaur, the Southern Cross, and the Ship, with the star Canopus, all invisible in the North, are called by the natives "paths" and "tens," because they are on the road to the south pole and are composed of many stars.

Ancient Mining on Lake Superior.—A paper by T. H. Lewis shows that the Lake Superior copper regions afford abundant evidences that an active mining industry was carried on there by the prehistoric aborigines. By inquiry among old miners, managers, explorers, and prospectors, the author ascertained that the ancient pits extended along the whole copper range from the extremity of Keeweenaw Point to and beyond the northwestern end of Gogebic Lake, a distance of fully one hundred and twenty miles. They are found also on the ranges to the north and to the south, as well as on the central range. Ancient pits are found, too, along the copper range in northern Wisconsin, and in the region northwest of Lake Superior, in Minnesota, and on the Canadian side of the international boundary line. The copper implements met with within the limits of Wisconsin, the author remarks, probably exceed in number those found in all the other States combined. They seem to be most numerous in the effigy-mound region, and have been found in the effigies themselves. Outside of Wisconsin copper implements have been discovered in nearly all the other States east of the Rocky Mountains, but they have been most frequently found in Minnesota, Michigan, Ohio, Iowa, and Illinois. There are also effigy mounds in all these States, except possibly Michigan.

The Phonograph in Indian Folk Lore.—Dr. J. Walter Fewkes recently related to the American Folk-lore Society experiments which he had made with the phonograph in recording the songs, legends, and folk lore of the Passamaquoddy Indians. He claimed extraordinary accuracy for this method, in that it is rid of the liability of the translator to incorporate his own interpretations with those embodied in the stories recorded by him. Besides fragments of legends, stories, ancient songs, counting-out rhymes, and conversations got from the older men of the tribe at Calais, Maine, he obtained from the lips of Noel Josephs, who sang it when the ceremony was last performed, an old song—with archaic words and very ancient music—used in the "snake-dance." He also took records of war-songs, a curious "trade-song," and the song sung by the chief on the evening of the first day of the celebration of his election. These songs have been set to music from the records taken on the wax cylinders of the phonograph, and the words have been written out by the same means. Forty cylinders were filled with these records, some of which are stories yet unpublished. The results of the experiment are represented as showing that the phonograph is an important help to the study of Indian folk lore, both in preserving the tales and in the study of the composition of the music and the language.

Fresh-water Sponges in Florida.—Fresh-water sponges of the genus *Mezenia*, described by Edward Potts, were found in Florida on the stems of grass and roots of mangrove trees on the meadows near the head of a creek. The meadow is about twelve inches higher than the creek, and is subject to floods of fresh water during the rainy season, and occasional submergence in salt water. Notwithstanding the exposure to salt water and subsequent desiccation of weeks or possibly of months, the gemmules of these sponges preserved their vitality and germinated freely when placed in water. Differences were observed between the roughened gemmules of the sponges growing on the mangrove roots and the smooth ones of those growing on the grass stems. The specimens, in another package, of the same genus and of *Spongilla* were found adhering to the barnacles on the rocky bottom of a rapidly flowing creek; the barnacles having been brought up by the backing up of the salt water, and then become accustomed to live in fresh water. The *Spongillas* in certain features of detail resemble some lacustrine forms found on the Catskill Mountains and at sites in Pennsylvania and New Jersey.

Philosophy of Spectacle-frames.—The importance of a proper construction and adaptation of spectacle-frames is enforced by Dr. Charles Hermon Thomas in a paper on that subject. The results of the most accurate refractive measurements may be vitiated by a faulty position of the correcting glasses; and new sources of eye-strain may be created by the very means adopted to remove an existing fault. The optical center of a lens is generally that part of the glass which we wish to bring before the pupil, as that part of the lens and the area immediately surrounding it are freest from aberrations of all sorts—distort the least. Occasionally, however, it may be desirable to displace that point by a definite amount; in any case, we should insist on having the optician carry out our directions as regards the manner of mounting and the position of the glass with the same exactness that he employs in making it of the proper strength. The purpose of the spectacle-frame is to hold a pair of glasses before the eyes in a definite position and with the least possible annoyance to the wearer. The plans for the construction of spectacle-bridges devised by the author in 1878 provided for a wide range of adaptability to individual faces. The material of the frames should usually be gold of good quality, and of a weight as light as is consistent with strength and steadiness. Steel rusts too readily and is not well adapted to the adjustments frequently required. The lenses should be as large as the face of the wearer permits, so that the eyes may be well covered in their ordinary lateral movements. The reflections from the edges of frameless glasses which annoy many may be avoided by slightly dulling the polish on the lower edge. The glasses should be worn as close to the eyes as possible without touching the lashes. Occasionally, when the lashes are especially long, with feathery or uneven ends, they should be neatly trimmed with the scissors, which is best practiced when the eyes are closed. It is also to be borne in mind that the subject has an artistic aspect, and that by giving proper consideration to this phase much may be done to remove the prejudice which frequently attaches to the wearing of glasses.

The Niagara Reservation.—The Commissioners of the State Reservation at Niagara, in their report for 1890, insist on the importance of making adequate provision for permanent improvements at Niagara, and especially of the restoration of the territory of the reservation to a state of natural simplicity and beauty. The work of restoration has for several years presented itself as that which should principally engage the attention of the board. Its applications to the Legislature for appropriations do not, however, seem to have been appreciated. But, in 1889, the grant of $15,000 for "repairs of roads, bridges, and betterments," enabled them to make a beginning, and they created a breakwater for the protection of the shore of Goat Island against erosion. Besides this $15,000 the appropriations for the maintenance and improvement of the reservation have in all not exceeded $75,000 since 1883; in return the commissioners have paid into the treasury, from the "earnings" of the reservation, $24,395, leaving $50,604 as what the reservation actually cost the State for maintenance during seven years. "To educated tourists, whether native or foreign," the commissioners say, "the disinclination of this great and prosperous State to provide means for the restoration of the scenery of the Falls of Niagara must appear somewhat surprising if not inexplicable. The fame of no other natural phenomenon in the world equals that of New York's great cataract." The popular approval of the State's acquisition of the falls has been exhibited so often and in so many ways that it can not be mistaken; and public condemnation, also often shown, of propositions to mar the falls for the sake of money-making schemes, has been significant, and gratifying to all who are interested in Niagara.

Firing Porcelain with Petroleum.—The porcelain manufacturers of Limoges, France, have been seeking for many years means of cheapening the cost of firing their wares, the expense for fuel there being two or three times greater than in England and Bohemia. Wages were reduced and new processes were tried without securing the object aimed at, till at last petroleum and residuum oils were tried, when results were gained far better than had been anticipated. The heat was found absolutely pure. No gases or smoke discolored the china, which came from the kiln whiter and in better condition than when it is fired by the heat of wood. In the muffles there was a decided advantage. The delicate colors, which show at once the presence of the slightest quantities of gas, were perfect. Consul Griffin thinks that this new discovery promises to revolutionize the whole porcelain industry. It is estimated that, by employing these oils, there will be a reduction of some fifteen or twenty per cent in the cost of making china.

NOTES.

The New Jersey Weather Service, organized in December, 1887, has already accumulated many valuable meteorological data. It has, at the request of the Superintendent of the Eleventh Census, prepared and forwarded a table showing the mean annual temperature and the mean annual rainfall, determined from observations made at fifty-eight stations, together with the length of each series from which the mean was determined; it has furnished the State Board of Health complete annual reports of twelve stations; and has distributed weather indications, cold-wave and frost warnings, and, during the growing season, weather-crop bulletins. As established and now in operation, it is an organization of voluntary observers, co-operating with the United States Weather Service, the State Agricultural Society, and the State Experiment Station; the national service detailing an experienced observer who acts as director and supervises the work carried on in an office furnished by the State Experiment Station.

In a paper on the Occurrence of Tin in Canned Goods, read in the American Chemical Society, Prof. H. A. Weber related a case of poisoning from eating pumpkin-pie made from canned pumpkin, in the investigation of which he had found as much as seven maximum or fifty or more minimum doses of tin salts in a pound of canned pumpkin. He had also found large traces of tin in canned fruits and tomatoes. The paper was very generally discussed, and it was agreed that the subject ought to be investigated. There is considerable difference of opinion among chemists concerning the extent and even the reality of danger from this source.

Prof. Springer informed the American Association that he has discovered a latent quality in aluminum which adapts it in a remarkable degree to use in the construction of sounding-boards. He has found that it differs from all other metals, so far as he is aware, in being free from the comparatively continuous and uniform higher partial tones that give the tone-color called metallic; and that it possesses an elasticity capable of sympathetic vibration uniform through a wide range of tone-pitch, that renders it in that respect superior to wood. The thickness of the sheet may be so reduced as to obtain the utmost amplitude of tone vibration without injury to the quality of the tone; and in this it is superior to both wood and other metals.

The photochronograph is an instrument intended to remove the personal equation in transit observations (astronomical) by means of photography. It was devised by Prof. Bigelow, of Woodstock College, and gave very satisfactory results as a first experiment with the star Alpha Aquilæ. The first apparatus was soon superseded by a second, and the second by a third, each being improved as the experiments suggested. An account of the instrument and its workings is given in a special publication of Georgetown College Observatory.

The Association of Agricultural Colleges and Experiment Stations adopted a resolution, at its recent meeting in Washington, asking the Secretary of Agriculture, in the interest of forest preservation, to secure the passage of laws exempting from sale or pre-emption Government forest lands now unsold, and to cause them to be surveyed, reported upon, and protected. It also suggested that the Weather Bureau organize and, co-operating with the agricultural colleges and stations, assist in maintaining a study of climatology in its relations to farming; and that the sphere of this work should be enlarged to include the physics, conditions, and changes of agricultural soils.

A cavern was discovered lately on the slope of the mountain at Baden which had evidently been used in the middle ages and long previously. Remains of the foundations of a vestibule were found at the entrance. In a niche hewn out of the rock was an altar with the sacrificial stone table. In front of the cavern was a regularly constructed building, fully ten feet below the surface of the ground above, designed probably to conceal the cavern behind, which may have been employed as a temple to Mithra. There were two stalls for horses, fragments of utensils, knives, flint arrow-heads, and carved bones, mixed up with Roman coins, lamps, and stamped tiles.

A course of lectures on the work of the Rothamstead Agricultural Station was delivered at Washington by Mr. R. Warrington, Vice-President of the Chemical Society of England, during the recent meeting of the Association of American Agricultural Colleges. At the conclusion of his lectures the speaker congratulated our country on having more than fifty experiment stations, each of them endowed with an income equal to or surpassing that possessed by Rothamstead; but advising his hearers that if at the end of fifty years each of our stations is to show a record of work done equal to or surpassing that accomplished by the old station in England, it will only be by each one pursuing its work in the same spirit of accuracy, thoroughness, and patience that has characterized the Rothamstead experiment.

The minor planets 296, 297, 298, 300, 302, and 303, have been named respectively Phaëtusa, Cecilia, Baptistina, Geraldina, Clarissa, and Josephina.

The address of Vice-President J. J. Stephenson before the Geological and Geographical Section of the American Association was on the relations of the Chemung and Catskill formations on the eastern side of the Appalachian basin. The speaker found that the deposits were not made in a closed sea, but that the influx of great rivers with their load of *débris* made conditions of the shallow basin such that life could not exist; and that in the present state of our knowledge we are not justified in including the Chemung period in the Carboniferous age.

The British consul at Hankow, China, writes that the varnish exported from that city is the gum of the *Rhus vernifera*, or varnish-bearing sumach. It has to be collected and strained in the dark, as light spoils the gum and causes it to cake with all the dirt in it. And it can not be strained in wet weather, because moisture causes it to solidify; but then it should only be used in wet weather, as, if the atmosphere is dry when it is rubbed on, it will always be sticky. As used by the Chinese, the varnish takes about a month to dry, and during the time it is drying it is poisonous to the eyes.

In his vice-presidential address at the American Association on the Evolution of Algebra, Prof. E. W. Hyde, in the Mathematical Section, made a concise presentation of the history of algebra from before the Christian era to the present time, and even projected the future of the science. After tracing it through the rhetorical stage of the ancients, in which the reasoning was done with words, and the syncopated stage of the middle ages and the revival of learning, when abbreviations were introduced and used instead of words, the author found it in the symbolical stage of the present, or that of arbitrary signs; and "finally, in the present century, we have noted the approach of multiple algebra from different and independent sources, whose value is the glorious future."

In a series of papers on The Unitary Science, the Science of the Future, Mr. Henry R. Rogers, of Dunkirk, N. Y., elucidates as the basis of the unitary philosophy the four cardinal principles of the unity or identity of all so-called forces; the conservation of force; the substantial character of force; and the identity of constitution of all celestial force.

The remains of about a hundred elephants have been found at Mont-Dall, in Brittany, where they are gathered on a surface of about nineteen hundred square metres. All the bones are broken, and it is thought that the animals must have been eaten by prehistoric men.

Two of the papers read at Washington before the Society for the Promotion of Agriculture are suggestive as to the nature of the agricultural character of soils. Prof. E. W. Hilgard held that maps showing simply the chemical constituents are of little value, and that a map truly to represent the agricultural quality of a soil should take into consideration geology, botany, climatic conditions, meteorology, and chemistry. Prof. Whitney, discussing the structure of soils and the circulation of soil moisture, showed that as much or more depends upon the physical condition of the soil as on the chemical composition. Where land is worn out, it is because a physical change has taken place, not because of any chemical exhaustion, for the chemicals are always there in abundance.

In the Biological Section of the American Association, Vice-President Coulter spoke of the future of systematic botany. Some one has said that the highest reach of the human mind is a natural system of classification. This simply means, he said, that when the results of all departments of botanical work are well in hand, then the systematists will be in a position to put on a sure foundation the structure they have always been planning. The real systematic botany, therefore, is to sum up and utilize the results of all other departments, and its work is well-nigh all in the future. It is bound to be the lsst expression of human thought with reference to plant-life, just as it wase the first.

OBITUARY NOTES.

Dr. Eduard Schönfeld, Director of the Observatory and Professor of Astronomy at Bonn, died May 1st, in the sixty-third year of his age. His attention was especially directed to astronomy while a student in the University of Marburg. In 1852 he became a pupil and assistant of Argelander, who was beginning his *Durchmusterung*, or survey of the stars of the northern hemisphere. In 1859 he was appointed Director of the Observatory at Mannheim, where he prepared two catalogues of the variable stars. On Argelander's death, in 1875, he was made his successor at Bonn. He extended the *Durchmusterung* to stars in zones down to 23° of southern declination.

M. Alexandre Edmond Becquerel, an eminent French physicist, died in Paris, May 11th, in the seventy-second year of his age. He was the son of Antoine César Becquerel, the founder of electro-chemics, and himself led a career hardly less distinguished. The investigations with which his name is connected include those on the laws of electro-chemical decomposition, the disengagement of heat by electricity passing in circuits, the disengagement of electricity by mechanical action, the properties of electrified bodies, the action of magnetism on bodies, the property of diamagnetism, the magnetic quality of oxygen, the constitution of the solar spectrum, the chemical action of light, phosphorescence, etc.; respecting which he made important discoveries and published valuable papers in the scientific journals. He also published books — treatises on Terrestrial Physics and Magnetism (1847) and Electricity and Magnetism (2 vols., 1855), and a *Précis d'Histoire* of Electricity and Magnetism (1858).

Mr. Norman R. Pogson, for thirty years Director of the Observatory at Madras, India, has recently died there. Till 1851 he was connected with Mr. Bishop's Observatory in Regent's Park, where he took part in the observations for forming the ecliptic charts that were published there. He then became an assistant in the Radcliffe Observatory at Oxford, and there discovered several minor planets, and in his investigations of variable stars fixed upon the number whose logarithm is 0·4, which has been adopted to express the ratio of the amount of light that separates two consecutive magnitudes. He left England in 1861 to take charge of the Madras Observatory, from which several volumes of observations were published under his direction.

Captain Cecilio Pujazon, Director of the Marine Observatory at San Fernando, near Cadiz, Spain, died April 15th, in his fifty-seventh year.

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